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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST.

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1907-1908

RALEIGH
E. M. UZZELL & CO., STATE PRINTERS AND BINDERS
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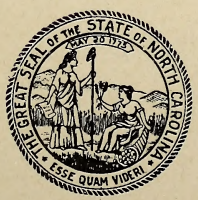

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1908

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., January 1, 1908.

To His Excellency, GOVERNOR R. B. GLENN:

I herewith have the honor to submit for your consideration my Biennial Report relating to the operations of the North Carolina Geological and Economic Survey for the fiscal years 1907 and 1908. It has only been possible to give in this report a brief outline of the work of the Survey and for more detailed information, reference should be made to the reports that have been published on the various subjects investigated.

Suggestions have been made regarding legislation relating to the perpetuation of forests and the prevention of forest fires; good roads and the appointment of a highway commission; drainage of swamp lands; and the cultivation of the oyster. I beg to call your particular attention to these, as I deem them of the most vital importance to the industrial advancement of North Carolina.

At the end of the report I have given a statement regarding the expenditures of the Survey, showing approximately the cost of each investigation taken up. This amount expended by the State has been largely augmented by the Federal Departments through co-operative work. Thus, the State Survey has been able to accomplish a great deal more than it could possibly have done if it had been dependent simply upon its own appropriation.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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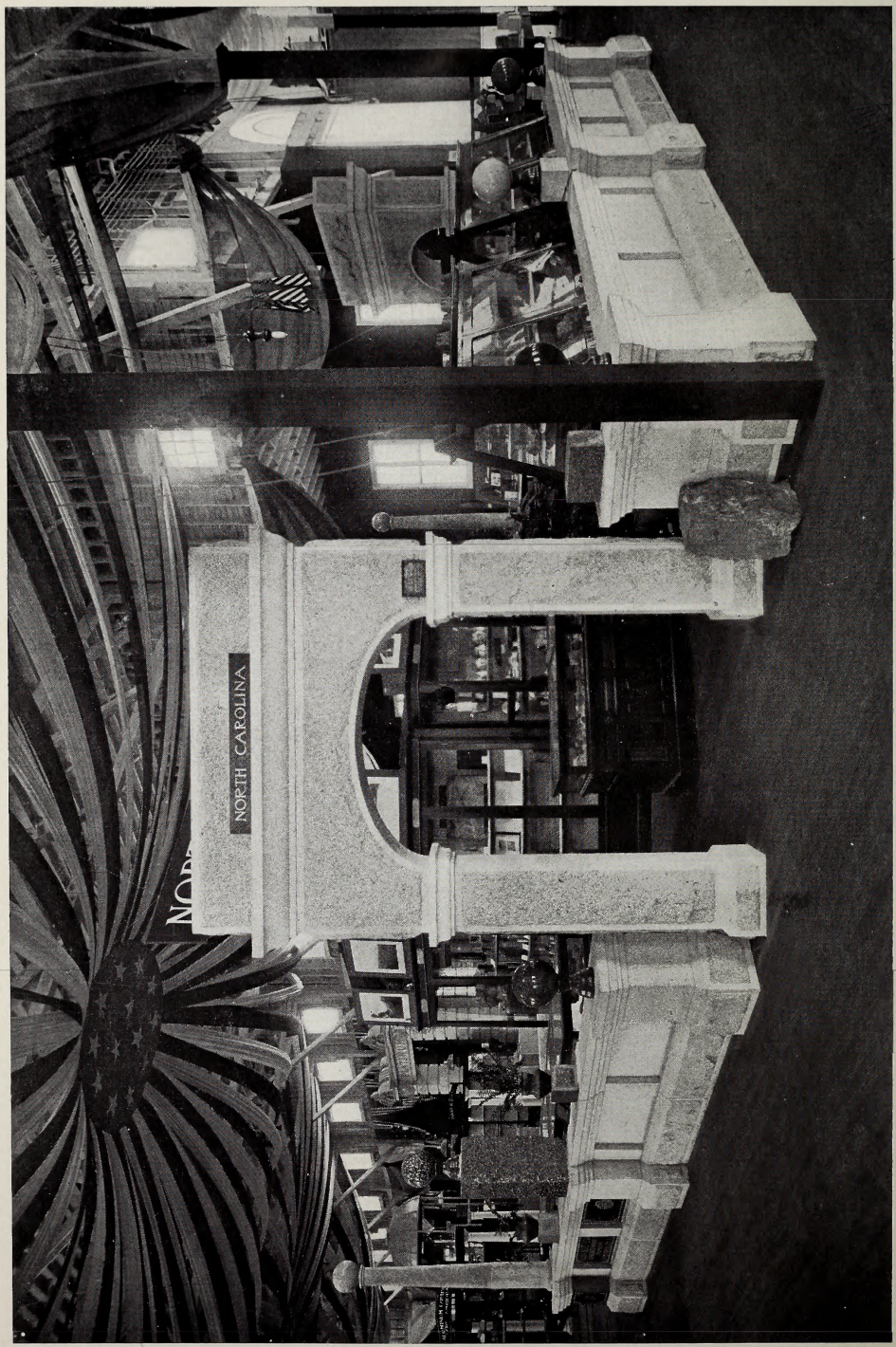
NORTH CAROLINA

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

ON THE OPERATIONS OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FOR THE TWO YEARS ENDING NOVEMBER 30, 1908.

By JOSEPH HYDE PRATT, State Geologist.

INTRODUCTION.

It is not possible in the Biennial Report to give more than a brief outline of the work that has been accomplished by the members of the Survey during the past two years. Detailed reports of the investigations are published as volumes, bulletins and Economic Papers, and to these the members of the General Assembly are respectfully referred.

The personnel of the North Carolina Geological and Economic Survey for the past two years has consisted of the following, who have been employed for either the whole or a part of their time:

Joseph Hyde Pratt, State Geologist.
F. B. Laney, Assistant State Geologist.
W. W. Ashe, Forester.
W. L. Spoon, Road Engineer.
E. W. Myers, Hydraulic Engineer.
J. E. Pogue, Jr., Assistant Geologist.

L. W. Stephenson,
E. W. Berry,
B. L. Miller,
Miss Julia A. Gardner,
Harvey Bassler,
} Geologists investigating Coastal Plain Resources.

R. L. Harrison,
R. C. Seitz,
M. W. Gray,
} Topographers.

R. T. Allen, Mineralogist.
A. S. Wheeler, Chemist.
Miss H. M. Berry, Secretary and Stenographer.

Besides the above, there are fourteen river observers who daily read the height of the river at their respective stations.

It is very gratifying to be able to state that Mr. W. W. Ashe has been employed as Forester and the State is to be congratulated in obtaining his services, as he is an expert forester and more familiar with the forests of North Carolina and what is needed for their protection and perpetuation than any other man.

Mr. E. W. Myers, who was formerly connected with the North Carolina Geological Survey, and then spent about eight years with the U. S. Reclamation Service, has returned to North Carolina and is now doing special work for the Survey as Hydraulic Engineer.

It is hoped that the present legislature will make it possible for the Survey to have associated on its staff several road engineers who can devote their whole time to road work in the different counties in North Carolina. Mr. W. L. Spoon, who is one of the road engineers of the U. S. Office of Public Roads, has assisted the State Survey in nearly all of its road work and has done a great deal toward the good roads cause in this State.

MINERAL AND GEOLOGICAL INVESTIGATIONS.

Mineral Investigations.

The Geological Survey continued during the past two years its investigations relating to the various mineral deposits in the State and has also gathered, in co-operation with the U. S. Geological Survey, statistics and information regarding the production of each mineral that has been mined or quarried in the State during each year. The results of these investigations have been published, as far as possible, in two of the series of Economic Papers, Nos. 14 and 15, on the Mining Industry of the State during 1906 and 1907 respectively. In these papers not only the statistics regarding the actual production of the minerals have been given, but also short descriptions of many of the mineral localities, especially new ones. Where a more complete examination and study has been made of a mineral locality, the results of such investigation are being published as separate bulletins on these subjects.

A very satisfactory arrangement has been made with the U. S. Geological Survey for co-operative work in the collecting of the mineral statistics, the following being the form of agreement:

Agreement.—For co-operation in statistical work between the United States Geological Survey and the Geological Survey of North Carolina:

In order to avoid a multiplicity of requests for statistical information from mine and quarry operations, and also in order that the State Geologist may

keep in touch with the mineral producers and the economic development of the mineral resources of the State, the following agreement between the State Geologist and the Director of the United States Geological Survey is made.

Early in the fall of each year (by October first if possible) a list of the mineral producers, as the United States Geological Survey has them, in the State of North Carolina, is to be sent to the State Geologist, who will check with the lists in the possession of the State Survey and make such corrections as he may be able to from the State Survey records. These lists will then be returned to the Division of Mineral Resources of the United States Geological Survey. Blanks for the collection of the statistics will be printed each year at the expense of the United States Geological Survey. Franked envelopes for the transmission of the statistical blanks will be addressed in the office of the Federal Survey and the blanks either numbered or, having the names and addresses of the operators written thereon, will be inclosed in the envelope with a circular letter. A franked envelope addressed to the State Geologist will be inclosed in the envelope with the circular letter and blanks, and all will then be sent to the State Geologist in order that he may inclose such additional circular to the operators as he may desire; *provided* such circular letter has been approved by the Director of the United States Geological Survey. By rubber stamp the State Geologist will indicate on the blank that the work is done by co-operation of the two surveys. On the return of the blanks to the State Geologist he will have each report carefully scrutinized and see that it is in proper form for tabulation. He will make such transcript for his own use as he may desire and then forward the reports to the United States Geological Survey.

The second and third requests for information will be prepared in the office of the Federal Survey and transmitted to the State Survey in the same manner as the first requests. The fourth requests, which are sent by registered mail, will have to be sent from Washington. After all attempts to secure returns by mail have been exhausted, the State Geological Survey will undertake to secure the reports from the delinquent operators by personal visits of himself or assistants.

In the publication of the statistical reports of the State Survey and of the United States Geological Survey, credit for the co-operative plan will be given.

Approved: (Signed) JOSEPH HYDE PRATT,

GEO. OTIS SMITH, *Director.* *State Geologist of N. C.*

In connection with the collection of these statistics relating to mineral production, a great deal of general information has been obtained and in some instances considerable field work has been done in determining something definite regarding the mineral deposit.

Gold.—In Economic Paper No. 14 there is included a report on Recent Changes in Gold Mining in North Carolina, the work on this paper being done by the State Geologist and Mr. A. A. Steel. There is also given a description of all the mines that have been operated at any time during the past three years and some idea regarding their commercial value. In Economic Paper No. 15 there is a further description of some new

gold properties and other notes on methods of mining and reduction of ores. These two papers, together with Bulletins Nos. 3 and 10, give a fairly complete account of the gold deposits of North Carolina and their possibilities.

Copper.—The investigation of the copper deposits of the State, which was commenced in 1906, has been continued and now, with the exception of a few small areas, all the copper districts have been thoroughly investigated geologically. Preliminary reports have been published of the work in the Virgilina District of Granville and Person counties, of the Gold Hill District in Rowan County, and the Swain County District. A bulletin is now in course of preparation on the Copper Ores of the Gold Hill District and later a volume will be published on the Copper Deposits of the State. These reports will be thoroughly illustrated, showing the location of the various copper deposits with plans of underground workings and maps showing the geological relation of the ore to the surrounding rocks. The field work for these reports has been done by Messrs. F. B. Laney and J. E. Pogue, Jr., under the supervision of the State Geologist.

Monazite.—The monazite area of the State has been extended during the past year by the discovery of workable deposits of monazite gravel in Alexander County. A special study has been made by the State Geologist on magnetic concentration and its application to the separation of monazite from its associated minerals. A short report on this subject is included in Economic Paper No. 15. It is now possible, by a magnetic separation, to produce a monazite sand as high as 98 per cent monazite.

Mineral Waters.—The data relating to mineral waters has been collected by the Survey office for a number of years and the analyses of these various waters that were made by chemists of the Survey and others have been brought together by the State Geologist and published as a report on the Mineral Waters of the State in Economic Paper No. 15. The mineral waters of the State offer a very promising field for investment and, while the shipment of mineral waters from the State has increased considerably during the past two years, there is still opportunity for a much larger increase in this business. One of the essential things to be done in regard to advancing the mineral water industry is a more thorough advertisement of the waters themselves.

Nearly all of the assistants of the Survey working in the field during the past year, regardless of the particular mineral they may have been working upon, were constantly collecting information regarding the occurrence of other minerals and this information is being edited at the office and will be included in the volume on the General Mineral Resources of the State.

Geological Investigations.

Special geological investigations have been made in various sections of the State in connection with the copper deposits of Davidson County and in the coastal plain region. Limited areas have also been investigated and mapped geologically in connection with the examination of different mineral localities. In the end it will be possible to prepare a geological map of the State that will show accurately the various geological formations.

Piedmont Geology.—During the summer of 1907 Messrs. F. B. Laney and J. E. Pogue, Jr., made a special study of the geology of the Gold Hill region and prepared a geological map of that section. During the field season of 1907 this work was continued into Davidson County, covering the Cid Copper District. A traverse map had been made of the district so that it was possible to make an accurate geological map of portions of those two counties. The map will cover an area of about 275 square miles. This map is now in the course of preparation and should be ready for publication sometime during the year of 1909.

The geological investigations in the Virgilina Copper District of Person and Granville counties were completed in the summer of 1907 and an outcrop map has already been published of this district.

Coastal Plain Geology.—During the field season of 1907-08, Messrs. L. W. Stephenson, E. W. Berry, B. L. Miller, Harvey Bassler and Miss Julia A. Gardner continued the geological investigations of the coastal plain region. The results of these investigations are now nearly all in manuscript form and a geological map to accompany the report has been prepared of the whole coastal plain region.

Mr. Miller has studied specially the Tertiary strata in Bladen, Carteret, Columbus, Craven, Duplin, Edgecombe, Greene, Jones, New Hanover, Pitt, Robeson, Sampson, Wayne, and Wilson counties.

Mr. E. W. Berry has finished his field work on the Cretaceous and later floras of North Carolina and assisted Mr. Stephenson by preparing a large number of reports upon specific localities for his use in stratigraphic work and in completing his work on the Cretaceous. He has also collected Tertiary plants from certain localities for Mr. Miller. He has completed the identification and illustration and characterization of the species collected. In all, about seventy species from twenty-one different localities within the Cretaceous belt have been discovered; about a dozen Tertiary species from three different localities; and a large Pleistocene flora from two different localities.

In connection with this work on the coastal plain region, there will be included in the volume a general report on the stratigraphy, underground

water supplies and a description of the peat and swamp lands. In connection with the underground water resources, each county will be taken up separately and discussed and statements made regarding the probability of obtaining artesian water and at what depths.

Mountain Region Geology.—Detailed geological work has been carried on in western North Carolina by F. B. Laney of the State Survey and Mr. Arthur Keith of the U. S. Geological Survey. Mr. Laney has made a study of the geological relations of the copper ores of Jackson County in the vicinity of Cullowhee. The field work of the U. S. Geological Survey is published in the form of geological folios and one of these, the Roan Mountain, has been published during the past two years. This folio covers portions of Mitchell and Yancey counties. The field work on a number of other sheets has been completed and it is expected that these will be published in the near future.

EXAMINATION OF MINERAL SPECIMENS.

The work that was undertaken in 1906 by the State Survey in cooperation with the United States Geological Survey regarding the mineralogical character of the black sands found in the southern Appalachians was continued until July 1, 1907, when the appropriation for this work by the Geological Survey ceased. The State Survey has, however, continued the work, although not on as large a scale as formerly. During these two years 609 samples have been examined and their commercial value determined. On many of these samples magnetic separations were made of the minerals and the percentage of each determined. The equipment that was reported in the last report is still installed in the concentrating plant at Chapel Hill, but, as stated above, on account of lack of funds, it has not been possible to utilize the plant as fully as it otherwise would have been.

It is impossible to make assays or chemical analyses free of charge, as the Survey has no special appropriation for this kind of work. Any mineral specimens, however, that are sent into the office will be examined and identified without any cost to the one sending the samples. There will also be given information as to the probable value of the sample and whether, in the opinion of the Survey office, an assay or further analytical work would be of any advantage. While in the field, the State Geologist and his assistants have examined a great many samples of minerals for different people and thus the actual number of mineral specimens determined for various people throughout the State is largely in excess of that mentioned above.

TOPOGRAPHIC AND TRAVERSE MAPPING OF THE STATE.

All the topographic and traverse mapping that has been done in North Carolina during the past two years has been by the U. S. Geological Survey and largely in co-operation with the North Carolina Geological and Economic Survey. All topographic mapping requires first that a base or traverse map be made and as many of the counties are very anxious to have county traverse maps, arrangements have been made by the State Survey to co-operate with the different counties by which these traverse maps can be prepared in advance of the topographic maps by men detailed from the U. S. Geological Survey. These base or traverse maps are kept on file by the U. S. Geological Survey and just as fast as possible they will be utilized in completing the topographic maps. These traverse maps, which are of value to the counties for educational work and in connection with good roads work, have been paid for in part by the county, and in part by the State Geological Survey. Thus far, Granville, Pitt and Beaufort counties have made arrangements for the preparation of such maps. The Granville County map is now nearly ready to go to the press. The field work on the Beaufort County map will be completed about the middle of December and the Pitt County map will be ready for the engraver at an early date. The value of these maps is being appreciated more and more all the time and their demand is increasing. Applications are constantly being made to the U. S. Geological Survey by North Carolina members of Congress for topographic mapping in their districts, but only a very small proportion of the applications made can be granted on account of the lack of funds. At the present rate of mapping of the State, it will be many years before a complete map of North Carolina will have been prepared and, considering the demand for the map and its value to the State, the State Geologist would recommend that a special appropriation be made for topographic mapping in North Carolina.

Suggestion Regarding an Act Authorizing the State Geologist to Co-operate with the Director of the United States Geological Survey in Making a Topographic Survey and Map of the State of North Carolina, and Making an Appropriation Therefor.

The General Assembly of North Carolina do enact:

Section 1. That in order to continue the execution and speedy completion of a topographic survey and map of this State, the State Geologist is hereby authorized to confer with the Director of the United

States Geological Survey and to accept the co-operation of the United States with this State in the execution of a topographic survey and map of this State, which is hereby authorized to be made; and that said State Geologist shall have the power to arrange with said Director of the United States Geological Survey, or his authorized representative, concerning the details of the said work, the method of its execution, and the order in point of time in which these surveys and maps of different parts of the State shall be completed: *Provided,* that the said Director of the United States Geological Survey shall agree to expend on the part of the United States upon said work a sum equal to that hereby appropriated for this purpose; *Provided,* also, that this sum is in excess of such sum as would be spent in the State for topographic mapping without any co-operation on the part of said State. In arranging the details heretofore referred to, the State Geologist shall, in addition to such other provisions as he may deem wise, require that the maps shall show the outlines of all counties, townships and extensive wooded areas, as existing on the ground at the time of the execution of the surveys; the location of all roads, streams, canals, lakes and rivers, and shall contain contour lines showing the elevation and depression, with vertical intervals of from ten to one hundred feet as may be hereafter mutually agreed upon by the said State Geologist and the said Director of the United States Geological Survey: *Provided,* also, that the resulting map shall fully recognize the co-operation of the State of North Carolina, and that as each manuscript sheet of the map is completed the State Geologist shall be furnished by the United States Geological Survey with photographic copies of the same, and as the engraving on each sheet is completed, the State Geologist shall be furnished by said Director with transfers from the copperplate of the same: *Provided,* further that the cost of engraving shall not be included in the sum that the said Director of the United States Geological Survey shall agree to expend in the State on the part of the United States.

SEC. 2. The sum of ten thousand dollars annually for six years, or so much thereof as may be necessary for carrying out the purposes of this act, is hereby appropriated out of any moneys in the treasury of the State not otherwise appropriated to be drawn upon as directed by the Geological Survey Board.

SEC. 3. This act shall be in force and effect after its ratification.

The following topographic maps have been completed during the past two years and are, or will be, in a few weeks ready for distribution: Beckford, Four Oaks and Winton Quadrangles covering portions of

Chowan, Gates, Hertford, Perquimans, Johnston, Wayne, Sampson, Harnett and Bertie counties, the area surveyed being 353 square miles, published on the scale of 1: 62,500 and with a contour interval of 10 feet.

The Great Coharrie Quadrangle in Sampson County was completed during the spring of 1908 and is now nearly ready for distribution.

The Gaffney Quadrangle, covering a part of Cleveland County, was also completed. These two sheets cover an area of 344 square miles and are published on the scale of 1: 62,500.

Traverse maps have been made of Granville and Beaufort counties and portions of Person, Rowan, Cabarrus, Stanley and Davidson counties.

GOOD ROADS.

Although but few of the counties of North Carolina are as yet constructing graded macadam roads, there are over half of them that are interested in one way or another in the construction of improved roads. Unfortunately, there are a large number of our people who are still not conversant with the good roads problem and do not realize the great advantages that a community derives from them. It is true, however, that the progressive men of the State who are working for industrial advancement realize most emphatically that one of the greatest causes that is retarding this advancement is the lack of good roads. Public roads are public necessities and the educational as well as the industrial advancement of the State is vitally dependent upon them. The work of good roads construction in the State would be greatly facilitated by State aid and it is the opinion of the State Geologist that there should be some co-operation on the part of the State with the counties.

First, because, as stated above, the public roads are public necessities and are ready to serve all classes. They represent common property of all the people and all the people have the right and privilege of using them.

Second. In connecting country with town, a good macadam road would often be traversing two or three counties so that in obtaining the best results from good roads they become inter-county questions.

Third. The construction of macadam road means an increased valuation of property along the road, which, in turn, means an increased revenue to the State as well as to the county.

Fourth. Educational facilities in the rural districts are dependent upon good roads and, where these exist, it is entirely feasible to substitute for a little school house of one room and one teacher a consolidated or graded school of half a dozen rooms and half a dozen teachers. A school house of one room and one teacher was good but a graded school

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of six rooms and six teachers is vastly superior and can be secured for the children of all the counties of the State if good roads are built in these counties. The consolidated or graded school is dependent upon graded roads and as the State, through its State Board of Education, has supervision over the schools, it is interested in the construction of good roads.

Fifth. Pleasure seekers and tourists from North Carolina and outside the State are specially interested in a system of good graded roads throughout North Carolina.

For these reasons, the problem of good roads construction in North Carolina becomes a State as well as a county problem.

The State can make no better investment than in the actual construction of good roads and, while it is not advocated that the State shall entirely build any piece of road in any particular district, it is strongly advocated that the State appropriate sufficient funds to enable it to co-operate with those counties which are willing to appropriate a like amount of money for the construction of good roads in the county. The following legislation was suggested at the Good Roads Congress held in Greensboro, October 14, 1908, and was approved by the N. C. Good Roads Association and the Geological Board:

SUGGESTED LEGISLATION FOR ESTABLISHING A STATE HIGHWAY COMMISSION DEFINING THE POWERS OF THE COMMISSION AND THE DUTIES OF THE HIGHWAY ENGINEER.

The General Assembly of North Carolina do enact:

SECTION 1. A State Highway Commission is hereby established, which shall consist of the State Geologist; the Commissioner of Agriculture; Professor of Civil Engineering in the University of North Carolina; Professor of Civil Engineering in the North Carolina College of Agriculture and Mechanic Arts; and one member of the Geological Survey Board.

SEC. 2. The Highway Commission shall appoint a competent civil engineer, who is experienced in the construction and maintenance of improved roads, as State Highway Engineer for a term of four years and until his successor is appointed. Said Highway Engineer shall receive a salary of two thousand five hundred dollars per annum, and shall be allowed his travelling expenses while officially employed. He shall furnish a bond in the sum of twenty-five hundred dollars for the faithful performance of his duty, said bond to be approved by the Governor, and he shall give his whole time and attention to the duties of his office. The

Highway Commission may appoint, as the work of the department requires, assistant engineers who shall be capable and competent civil engineers and experienced in road building, and other assistants, clerks and stenographers as may be required to carry out the provisions of this act, whose compensation shall be determined by the Highway Commission.

SEC. 3. The object and purpose of this Commission shall be to instruct, assist and co-operate in the building and improvement of the public roads, under the direction of the Highway Engineer, in such counties and townships of the State of North Carolina as shall comply with the provisions of this act. The Highway Commission may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best methods of road making and the best kinds of road material; and prepare, publish and distribute bulletins and reports on the subject of road improvement; and the Highway Engineer shall also gather and tabulate information and statistics on road building in North Carolina and disseminate the same throughout the State. The Highway Commission shall make a biennial report to the legislature of the work of the department.

SEC. 4. In order to obtain the benefits of this act, the County Commissioners in any county in this State may, at any time, by resolution, request the Highway Commission that any public road or section of road, located within said county, being at least one mile in length, or, being less than one mile in length, if an extension or connection with some permanently improved or paved street, or permanently improved highway of approved construction, be improved by the construction of a macadamized road, or a telford or other stone road, or a road constructed of gravel, brick or other suitable material, in such manner that the same, of whatever material constructed, shall, with reasonable repairs thereto, at all seasons of the year, be firm, smooth and convenient for travel; or whenever a road or section or improvement thereof is petitioned for by the owners of 51 per cent of the lineal feet along said road, or section thereof, praying the Board of County Commissioners to cause such roads to be improved under this act, it shall be the duty of the Board to make such request to the Highway Commission, if after viewing such road said Board of County Commissioners shall decide the improvement of such road to be just and to the best interest of the public, subject to the conditions as hereinafter provided. When more roads are applied for than can be constructed in one year, the Board of County Commissioners and Highway Engineer shall have power and authority to select from the roads petitioned for, the ones first to be constructed, having first regard

to the most important roads and the distribution of the benefits of this act to all parts of the county.

SEC. 5. The Highway Engineer shall, upon receipt of any such application, investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purpose of this act, taking into account the use, location and value of such highway or section thereof for the purpose of common traffic and travelling, and after such investigation, shall certify his approval or disapproval of such application. If he shall disapprove such application, he shall certify his reasons therefor to the Board of County Commissioners making the application.

SEC. 6. If the Highway Engineer shall approve of such application, he shall cause the highway or section thereof, therein described, to be mapped both in outline and profile. He shall indicate how much of such highway or section thereof may be improved by deviation from or alteration of the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness; or whenever such deviation or alteration is of advantage by reason of lessened gradients, and shall cause plans and specifications of such highway or section thereof to be made for telford, macadam or gravel roadway, or other suitable construction, taking into consideration the climate and soil, and the material to be had in the vicinity thereof, and the extent and nature of the traffic likely to be upon the highway, specifying in his judgement the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight nor more than sixteen feet in width, unless for special reasons to be stated by such Highway Engineer it is required that it shall be of greater width. All highways improved under the provisions of this act shall conform to the standard of construction established by the State Highway Department.

SEC. 7. Upon the completion of such maps, plans and specifications of a proposed improvement the State Highway Engineer shall cause an estimate to be made of the cost of construction of the same, and transmit the same to the Board of County Commissioners from which such resolution proceeded, together with a certified copy of such maps, plans and specifications, and of his certificate of the approval of the highway or section thereof so designated as aforesaid.

SEC. 8. After the receipt thereof upon a majority vote of such Board of County Commissioners, it may adopt a resolution that such highway or sections thereof so approved shall be constructed under the provisions

of this act, or of any existing act, and thereupon shall transmit a certified copy of such resolution to the State Highway Engineer.

SEC. 9. In case such proposed highway shall deviate from the existing highway, the officials making application must provide for securing the requisite right of way by condemnation proceedings or otherwise, prior to the actual commencement of the work of improvement, and shall secure release from damage to property by reason of change of grade.

SEC. 10. That upon the receipt of the application and certified copy of the resolution provided for in Section 7 the State Highway Engineer shall advertise for bids for two successive weeks in one newspaper of general circulation, published in the county in which the road is to be built, according to said plans and specifications which shall be on file at the County Commissioner's office and shall award such contract to the lowest responsible bidder, subject, however, to the approval of the County Commissioners. No contract shall be awarded at a greater sum than the estimate provided in Section 7; *Provided,* that when bids are received for such improvement, they shall be sealed bids and shall be protected with such other regulations as may be imposed by the County Commissioners, necessary to secure fair bids. But if no bid otherwise acceptable be made within such estimate, such Highway Engineer may amend his estimate, certify the same to the Board of County Commissioners and upon the adoption by it of a resolution as provided in Section 6, based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Said County Commissioners may reject any and all bids and before entering into any contract for such construction shall require a bond with sufficient sureties, or by a surety company of recognized standing, conditioned that if the proposal shall be accepted the party thereto will perform the work upon the terms proposed and within the time prescribed and in accordance with the plans and specifications, and as a bond of indemnity against any direct or indirect damage that shall be suffered or claimed during the construction of such road and until the same is accepted. The State of North Carolina shall in no case be liable for any damages suffered.

SEC. 11. Upon the completion of any highways rebuilt or improved under the provisions of this act, the Highway Engineer shall immediately ascertain the total cost and expense of the same and apportionment of the total cost and expense between the State and the county, and the Highway Engineer shall certify the total expense of said improvement to the County Commissioners, signifying the amounts contracted to be borne by the State and the county.

SEC. 12. One-fourth of the cost and expense of the construction

thereof shall be paid by the Treasurer of the State of North Carolina on the warrant of the State Auditor issued upon requisition of the State Highway Engineer, approved by the Chairman of the North Carolina Highway Commission, out of any specific appropriations made to carry out the provisions of this act, and three-fourths of the cost and expense thereof shall be a county charge in the first instance and shall be paid by the Treasurer of the county in which such highway or section thereof is located upon the order of the County Commissioners upon the requisition of the State Highway Engineer out of any funds in the county treasury for the construction of improved highways under the provisions of this act; *Provided,* that not more than five thousand dollars shall be paid by the State for highway construction work in any one county in a single year.

SEC. 13. No money shall be advanced by the State of North Carolina or by the County Commissioners in payment of the cost and expense of construction provided herein except as the work of actual construction progresses to be paid upon estimates made by the engineer in charge of the work, and in no case shall the payment or payments of the State of North Carolina and the County Commissioners made thus prior to the completion of the work be in excess of eighty per centum of the value of the work performed, and in all cases twenty per centum must be held until the completion of the work, according to the plans and specifications, and every county or township availing itself of the provisions of this act shall, because of having accepted such State aid, contract and bind itself to maintain and keep said road in good and efficient repair, for the free use of the public.

SEC. 14. Every contract authorized to be made by the State Highway Commission, under the provisions of this act, shall be made in the name of the State of North Carolina, and shall be signed by the Highway Engineer and attested by the Chairman of the Highway Commission, and must be approved by the Board of County Commissioners of the county in which the improvement is to be made; *Provided* further, that no contract for any highway improvement shall be let by the State Highway Commission, nor shall any work be authorized under the provisions of this act, until the written agreement of the County Commisioners of the county in which the proposed improvement is to be made agreeing to assume their respective share of the cost thereof, as hereinbefore provided, shall be on file in the office of the State Highway Department, and shall have been approved as to form and legality by the Attorney-General.

SEC. 15. The construction and improvement of highways and sections thereof under the provisions of this act shall be taken up and carried

forward in the order in which they are finally designated, as determined by the date of the receipt in each case of the certified copy of the resolution provided in Section 8 by the Highway Engineer as hereinbefore provided.

SEC. 16. The County Commissioners, or County Road Commissioners, when such exist, shall have the authority to select the kind of materials to be used in improving any road under the provisions of this act. The State Highway Engineer shall furnish to the County Commissioners information as to the probable cost of improved highways, as defined in this section.

SEC. 17. Counties may agree among themselves to contribute their combined proportion of the total expense of construction, herein provided, to be borne by them for the construction of County Line Roads in any proportion agreed upon by the several Boards of County Commissioners, but in no case shall any county pay less than ten per centum of the entire expense of such improvements.

SEC. 18. Whenever any turnpike or improved road now constructed is in need of reconstruction, it may be done under the provisions of this act in the same manner as provided for herein for the construction of new improved roads, and all provisions herein applying to the construction of improved roads shall apply to such reconstruction of roads, and such roads must be reconstructed in accordance with the provisions herein.

SEC. 19. The money appropriated from time to time by the State of North Carolina for the purpose of carrying out the provisions of this act shall not be used in any other manner or for any other purpose than as herein provided; *Provided,* that the amounts appropriated shall be divided among the counties of the State in proportion to the amount of State taxes that each county pays into the State Treasury, but the said amount apportioned to each county shall remain in the State Treasury until applied for under the provisions of this act; *Provided* further, that if not applied for by the county to which they have been allotted by the first day of July of each year, such amounts shall be re-apportioned among those counties which have applied for aid; *Provided* further, that on the first day of January of each year any amounts remaining unapplied for by the counties shall be added to the regular appropriation for the ensuing year and be apportioned among the counties as provided above as their allotment for that year.

SEC. 20. The State Highway Commission shall meet twice a year, once in June and again in January, at the call of the Chairman of the Commission. The members of the Commission, except the State Geolo-

gist and Commissioner of Agriculture, shall receive four dollars per diem and all the commissioners shall be allowed their actual expenses in attending these meetings, which amounts shall be paid out of the Highway Commission fund.

SEC. 21. The said Highway Engineer shall make semi-annual reports to the Highway Commission at their regular meetings on the progress of his work and the financial condition of his department.

SEC. 22. The sum of $150,000 annually is hereby appropriated out of any moneys in the Treasury not otherwise appropriated for the purpose of carrying out the provisions of this act.

SEC. 23. Nothing in this act shall be construed to be in conflict with any act now in force.

SEC. 24. This act shall be in force from and after its ratification.

The Geological Survey has been attempting, as far as possible, to give assistance in regard to the location of roads and the best methods of constructing same in the various counties. Numerous addresses have been made in the counties regarding the value of public roads and best methods of constructing same. In co-operation with the Office of Public Roads of the United States Department of Agriculture, the State Survey has been enabled to arrange for special lectures on various phases of good roads work, which have been delivered at Andrews, Asheville, Bayboro, Brevard, Bryson City, Camden, Columbia, Columbus, Creswell, Edenton, Elizabeth City, Franklin, Gatesville, Greenville, Greensboro, Haysville, Hendersonville, Hertford, Marion, Maysville, Moyock, Murphy, Plymouth, Newbern, Richmond, Robbinsville, Rutherfordton, Shiloh, Washington, Williamston, Waynesville and Webster. Special inspection was also made of several roads in the course of construction, including in some instances a survey and the preparation of specifications and estimates. This included a sand-clay road near Clinton, Sampson County; a macadam road leading from Tryon to Lynn, Polk County; a macadam road from Spray to Leaksville, Rockingham County; a graded dirt turnpike from North Wilkesboro, Wilkes County, to Jefferson, Ashe County; a proposed object lesson of macadam road at Shelby, Cleveland County and Windsor, Bertie County; survey and estimate of cost of macadam road at Hillsboro, Orange County; the inspection of local conditions as to kind of roads to be built at Southport, Brunswick County; and an inspection regarding the best method of improving the streets of Greenville, Pitt County. Mr. W. L. Spoon has done most of the work referred to above. The State Geologist has given a number of the addresses.

HYDROGRAPHY.

Stream Measurement.

In co-operation with the U. S. Geological Survey, considerable work has been done in connection with the various problems relating to water supply and water power in North Carolina. There were maintained during the past two years thirty gaging stations, of which the State is paying the salaries of twelve of the gage readers and the U. S. Geological Survey the balance. These stations are located as follows:

Gaging Stations Maintained in North Carolina by U. S. Geological Survey and North Carolina Geological and Economic Survey.

	River.	Locality.	County.
1.	Broad.	Uree.	Rutherford.
2.	Catawba.	Morganton.	Burke.
3.	Cullasaja.	Cullasaja.	Macon.
4.	Cheoah.	Millsaps.	Graham.
5.	Dan.	Madison.	Rockingham.
6.	Davidsons.	Davidsons.	Transylvania.
7.	French Broad.	Asheville.	Buncombe.
8.	French Broad.	Rosman.	Transylvania.
9.	Green.	Saluda.	Polk.
10.	Hiwassee.	Murphy.	Cherokee.
11.	Hiwassee.	Hayesville.	Clay.
12.	Linville.	Fonta Flora.	Burke.
13.	Little River.	Calhoun.	Alexander.
14.	Little Tennessee.	Judson.	Swain.
15.	Little Tennessee.	Franklin.	Macon.
16.	Nantahala.	Nantahala.	Swain.
17.	N. Fork Mills.	Pinkbed.	Henderson.
18.	S. Fork Mills.	Sitton.	Henderson.
19.	North Toe.	Spruce Pine.	Mitchell.
20.	Oconalufty.	Cherokee.	Swain.
21.	Pigeon.	Canton.	Haywood.
22.	Scotts Creek.	Dillsboro.	Jackson.
23.	Second Broad.	Logans Store.	Rutherford.
24.	Swannanoa.	Swannanoa.	Buncombe.
25.	Tuckaseegee.	Bryson City.	Swain.
26.	Tuckaseegee.	East Laport.	Jackson.
27.	Tusquitee Creek.	Hayesville.	Clay.
28.	Valley River.	Tomotla.	Cherokee.
29.	Yadkin.	N. Wilkesboro.	Wilkes.
30.	Yadkin.	Salisbury.	Rowan.

Besides the daily gage readings of the height of the water in the streams, there has been made at intervals during the past two years discharge measurements, which give the actual amount of water passing

the station each minute. The data obtained at these stations are used in determining the value of the waterpowers on the various streams and rivers. In co-operation with the Federal Survey, a nearly complete report on the waterpowers of the State has been prepared and the manuscript is now being edited. The waterpowers of the State are one of its most valuable resources and this State should take every precaution to maintain these and it is of the most vital importance that the forests on the mountain slopes in which these streams have their sources should be protected, if the waterpowers are to be kept at their present efficiency.

There has also been prepared a report on the Water Resources of the Coastal Plain Region which is already in manuscript form and will be published as part of the volume on the coastal plain region of the State. In this report descriptions are given of each county in eastern North Carolina regarding its water resources and there is given below the description of Bertie County which will illustrate the scope of the report.

Water Resources (Bertie County).—The lower sandy portions of the Pleistocene formations furnish the greater part of the supply of water for domestic use. Driven wells are gradually taking the place of open wells and, with the exception of Aulander, the villages now contain more of the former than the latter. The wells range in depth from 8 to 35 feet with a very few as deep as 60 feet. Those exceeding 35 feet derive their water from the underlying Miocene. The water from the Pleistocene beds is almost everywhere soft, although in places it is ferruginous. Many springs occur along the scarps and in the stream valleys, but they are small and unimportant.

But few deep wells have been drilled in Bertie County. Seven or eight years ago at Windsor a 2½-inch pipe was sunk 250 feet, obtaining a small flow which, after continuing for about three months, suddenly stopped, due to the entrance of sand into the pipe. In 1905 a deep well was drilled for the town near the one above described. The elevation of the mouth of the well above sea-level is about 10 feet. A small flow was obtained at a depth of 250 feet and an 8-inch casing was driven to that depth and drilling continued, using a 6-inch casing. At 560 feet a flow of approximately 10 gallons per minute was obtained, but was lost either by caving or by casing past the water stratum. Ten feet deeper, at 570 feet, a flow of 4 gallons per minute was struck. This flow was also lost. Drilling was continued to a depth of 585 feet, but no other water-bearing beds were penetrated. An attempt was made to pull up the 6-inch casing, but it parted about 10 feet below the bottom of the 8-inch casing, and only the upper 260 feet was withdrawn. The water from the 250-foot horizon contains sodium bicarbonate and has a strong

sulphur odor and taste. The three flows obtained were probably from the Cape Fear formation which underlies the Miocene.

An attempt to get a flowing well was made about three years ago in Lewiston. A 2-inch pipe is reported to have been sunk 164 feet where drilling was stopped by quicksand. Water struck at about 100 feet rose to within a few feet of the surface. This well probably passed through the Miocene and entered the Cape Fear beds. At Avoca a pipe was driven to a depth of 180 feet without securing a flow of water. At this depth quicksand interfered so seriously with the progress of the work that the undertaking was abandoned.

Artesian Prospects.—Abundant supplies of potable water may be obtained from the Miocene and Cape Fear deposits underlying the county. It is believed that the depths at which the water-bearing beds will be encountered will vary considerably in the different parts of the county. At Windsor, in the south central part, a flow of sodium bicarbonate water was found at 250 feet. Stronger flows were found at 560 and 570 feet. In the western part of the county the depth to these horizons will be considerably less. Bed-rock would probably be encountered 500 to 600 feet below the surface in the extreme northwestern corner. The water from deep wells in the central and western parts of the county will be high in sodium bicarbonate, with considerable amounts of chlorine and sulphates. In the eastern portion of the county water-bearing horizons in the Miocene yielding a somewhat harder water would probably be penetrated at depths ranging from 35 to 400 or 500 feet below the surface. With the exception of Windsor, none of the larger towns are situated favorably for obtaining flowing wells. It is doubtful if any well drilled within the county will overflow at elevations of over a few feet above sea-level.

Mineral Waters.—A preliminary investigation has been made upon the mineral waters of North Carolina and many samples have been collected and analyzed. The results of this investigation are published in Economic Paper No. 15 on the Mining Industry in the State for 1907.

SWAMP LANDS AND DRAINAGE.

Another line of investigation that has been taken up during the past two years is the investigation of the swamp lands of North Carolina. While only a preliminary start has been made in this work, it still has attracted a great deal of attention and bids fair to become one of the more important works of the Geological Survey. Several preliminary examinations were made in 1907 of various swamp lands to determine:

First. The character of the swamp, whether the soil was suitable for agricultural purposes or whether it was too peaty in character.

Second. Whether the peat swamps contained this material in quantity and of such quality that it could be marketed.

Third. Whether the swamps could be drained.

Several areas were examined in Bladen, Carteret, Craven, Duplin, Onslow, Pasquotank, Pender and Wilson counties. Some of these showed areas of peat of commercial quality and quantity and others showed swamps, the soil of which is adapted to agricultural purposes when drained. These swamp lands have attracted the attention of investors for many years, as their value for agricultural purposes was recognized. One of the drawbacks to those swamp areas that were covered with timber was the cost of clearing. Now, however, since the timber itself has become of such value that its removal is profitable, it has reduced the cost of clearing. Also the advance made in dredges and methods of drainage makes it now possible to drain these large areas of swamp land at a figure commeasurable with the increased value of the land itself. Where the swamp lands are composed of thick beds of peat, their agricultural value is not very large, on account of the cost of preparing the land and bringing it into a state of cultivation. This is due to the large amount of water held mechanically by the peat, which in time causes a shrinkage or settling of the land; the very large percentage of humus; and lack of other available constituents that are necessary to make good crops. There are, however, many of our swamp areas where the percentage of peat is low, but still in sufficient quantities to give the right amount of humus to the land, after it is drained, and making very rich and productive soils. As an illustration of the value of some of our swamp lands after they have been drained, I would like to state what has actually taken place during the past year at one locality in North Carolina.

About five miles southeast of Pinetown, Beaufort County, a canal has been constructed through one of our large swamp areas for a distance of five miles and having a width of thirty feet and depth of seven feet. Before this canal was begun, the people living in the vicinity of the swamp all claimed that it would be impossible to drain the swamp as there was not sufficient fall to take care of the water. The ones who were interested in the project, however, had had a survey made of the swamp and were confident that there was a sufficient fall along the line of the canal to take care of all the water and drain the land. As the canal was being constructed, it was found necessary at the end of a mile to construct a retaining dam six feet high in order to keep sufficient water in the canal to float the dredge. After another mile and a quarter of the

canal had been constructed, it was found necessary to build another dam six feet high. After the five miles of canal had been constructed, the total fall in that distance was found to be a little over 12 feet. The dredge was then taken back down the canal and the dams removed. During the extreme heavy rains of the past summer in eastern North Carolina, this canal was able to take care of all the excess water, and, as far as I could ascertain, it never rose over 15 inches in the canal. Last spring, in order to determine the actual agricultural value of the land drained, 10 acres bordering on the canal were cleared by cutting down the trees and underbrush and burning them, leaving the stumps. Corn was planted by means of a hand-drill made out of a piece of hollow gum wood. There was no opportunity for plowing the field, so the corn was planted by simply running the drill into the ground and dropping the seed. It was also impossible to cultivate the corn as it was growing, on account of the stumps. The fires, however, had destroyed all of the undergrowth so that there were no weeds to interfere with the growth of the corn. This tract produced an average of 40 bushels of corn to the acre, which will give an idea of the great value of this land for agricultural purposes. With the construction of lateral canals, this main canal will be capable of draining from 6,000 to 7,000 acres. Another advantage gained by the drainage of these swamp lands is the construction of a good system of roads along the banks of the canals. In connection with the canal just referred to, a road bed has been made along its bank.

A complete survey has been made of Angola Bay swamp in Pender and Duplin counties and plans and specifications drawn up for its drainage. This work was done by the Drainage Division of the U. S. Department of Agriculture.

The results of this preliminary work have aroused a great deal of interest in regard to the drainage of swamp lands and this culminated in a Drainage Convention which was held at Newbern, September 9 and 10, 1908. At this convention there were present about seventy delegates from Beaufort, Bladen, Brunswick, Camden, Carteret, Columbus, Craven, Currituck, Greene, Guilford, Harnett, Hyde, Jones, New Hanover, Onslow, Orange, Pamlico, Pasquotank, Pender, Pitt, Wake, and Washington counties. A most enthusiastic convention was held which resulted in the drafting by the convention of a bill regarding drainage that it is hoped the General Assembly of 1909 will adopt. The proceedings of this convention are published in Economic Paper No. 17.

The estimated swamp area in eastern North Carolina is 4,505 square miles divided approximately as follows:

Swamp Area in Eastern North Carolina.

County.	No. sq. miles.	County.	No. sq. miles.
Beaufort	177	Jones	139
Bertie	57	Martin	86
Bladen	192	New Hanover	25
Brunswick	300	Onslow	134
Camden	162	Pamlico	325
Carteret	126	Pasquotank	80
Chowan	30	Pender	370
Columbus	300	Perquimans	92
Craven	238	Pitt	40
Cumberland	30	Robeson	130
Currituck	40	Sampson	18
Dare	344	Tyrrell	251
Duplin	125	Washington	262
Gates	45		
Hyde	387	Total No. square miles	4,505

Peat Deposits.—Many of these areas are not suitable for agricultural purposes, even if they were drained; other areas offer too great mechanical difficulties in drainage to make it practicable; still others are more suitable for growing timber than for other agricultural purposes; and still others contain deposits of peat from a few feet to nearly 20 feet in depth. While some of these can be reclaimed for agricultural purposes, they offer difficulties in the way of bringing the land itself into the condition that it will produce crops. Some of these contain good peat of commercial quality from 10 to 15 feet deep which is very free from roots, stumps, sand, etc. One of these on the outskirts of Elizabeth City, Pasquotank County, was tested and two carloads of the peat collected and shipped to the Fuel Testing Plant of the U. S. Geological Survey, located in the Jamestown Exposition grounds. Here an examination was made as to its quality. It contained over 50 per cent of water but, for peat, was low in ash and it will make a good fuel. The value of peat as a fuel is well recognized and, as it burns without soot, with little smoke and leaves practically no clinkers, it makes a very clean fuel, especially for domestic purposes. It can also be used for metallurgical purposes and boilers. It is undoubtedly true that where peat is used as a fuel under boilers that the boilers will last considerably longer than where coal is the fuel used.

Perhaps the main reason why the peat of North Carolina and other portions of the United States has not been utilized as a source of fuel is that other forms of fuel have been so abundant and could be produced so cheaply that there has been no apparent necessity for attempting to utilize peat, and, therefore, but little attention has been given to this

fuel. With, however, the large demand that has been made upon the coal supplies of this country and the warning that has been given in regard to their waste and need of conservation, government and State officials have begun to look for other sources of fuel and peat is claiming their attention.

There is one method for the utilization of peat that may prove of considerable value to North Carolina, which is the establishment at the peat bog of either a gas producer and electrical generator; or boiler, dynamo and generator and thus produce electric power at the bog, transmitting same to the nearby towns for lighting and power purposes. These plants could be made as small as the requirements of the town call for, but so arranged that they could be readily increased with the demand for additional power. It is absolutely necessary, before undertaking the operation of a peat deposit, to determine first the quality of the peat, whether it is of such grade that it will make a fuel of commercial value; second, the extent of the deposit, whether it is of sufficient area to warrant the establishment of a plant for preparing it for market; third, the determination of the cost of digging, drying and preparing the peat for market.

The Survey will be glad to examine samples of peat and, in sending them in, it is earnestly requested that as much information as possible be given regarding the peat deposit, its area, depth, location, etc. The following scheme for description of peat deposits is used by the Survey and the one sending the sample should fill out the blank as fully as possible:

FORM FOR DESCRIPTION OF PEAT DEPOSITS.

1. Exact location, county, distance from nearest large town, roads by which it may be reached.

2. Distance from the nearest railroad and boat lines. (Character of wagon roads nearby.)

3. Address of owner or agent.

4. Approximate area of the surface.

5. The character of the surrounding lands (cleared or wooded, swampy or dry).

6. Type of deposit: (a) Flat, undrained area (pocosen type); (b) Marginal to stream or sound; (2) Basin, deep or shallow.

7. The kind of plant growth on the surface of the deposit (grasses, sedges, nearly pure or mixed with other herbaceous types, reeds or cane, shrubs and moss, or trees, etc. If trees have been cleared or burned off, note, with kinds removed, if this can be determined, and the condition of stumps and roots, whether sound or rotten.

8. Possibilities of drainage, slope of surface of peat, streams through the bog or near by it.

9. (a) Character and thickness of the surface layer to good peat; (b) Depth of the whole deposit. For reconnaissance work, a small deposit may be tested by a single line of holes along axis of the bog. Shallow, 4 ft. or less, deposits, even if of large area, have little value unless very pure.

10. The amount of decomposition of the lower layers of the peat below the surface litter should be determined by examination of samples carefully taken, and the acidity, color, plasticity and odor noted as well as any change of color or of other properties after exposure to the air. (Litmus paper should be used to test acidity.) The lower layers of peat formed in wet basins usually of different origin from the upper, and of different structure.

11. Presence of logs, stumps and other coarse vegetable matter, and of layers of clay, sand or stones, at any depth, must always be noted, as well as the condition or decomposition of the former.

12. The kind of material below the peat, whether gravel, sand, clay or marl. Very wet clay will be about as penetrable as peat, hence, where found, samples must be taken carefully to determine the depth of peat.

13. Final sampling should include more careful testing of (a) uniformity of texture of the various beds; (b) purity and freedom from logs and other obstructions; (c) depth to and at which these occur, if this is uniform; (d) the extent of the beds in area and thickness; (e) the plasticity of the peat, coarseness and degree of decomposition; (f) color, whether light, brown or black; (g) depth to the various types found.

14. Samples should be taken from each hole made to show the character of the different strata encountered. Samples from different depths should be kept separate and each labelled. Those from the same depth from different holes in the same deposit may be mixed. Two samples, a small wet one, placed in a water-tight container, preferably the wooden mailing case, and a larger one to be put in a cloth bag, where it may be allowed to dry out before shipping.

15. When the sounder meets an obstruction, it is always better to pull it up and push it down in another place than to try to force it through the obstruction at the risk of breaking the rod and losing the sounder. There should be no deviation from this rule.

A preliminary examination has been made of the peat deposits by Prof. Charles A. Davis of the U. S. Geological Survey and the results are published in Economic Paper 15.

The State Geologist was instrumental in organizing the American Peat Society, and was elected President of the Society. A quarterly journal is being published that is very materially assisting the peat industry.

FORESTRY.

Considerable advance has been made in forestry work in North Carolina during the past year, which has been due to the employment of a forester. This has been made possible by the State Survey co-operating with the State Board of Education, according to the following agreement:

AGREEMENT BETWEEN THE STATE BOARD OF EDUCATION AND THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

In order to thoroughly investigate the forest lands belonging to the State Board of Education in regard to their timber and agricultural value; the perpetuation of such forest areas as is deemed advisable; the prevention of forest fires throughout the State; the reforestation of various areas in the State and other forest problems that may arise, the State Board of Education hereby agrees to appropriate for this work the sum of twelve hundred dollars ($1200.00), the same to be paid to the State Geologist for disbursement, in monthly installments of $100.00, beginning February 1, 1907.

The State Geological and Economic Survey also agrees to appropriate out of its fund a like amount for the forestry work.

Where it is necessary to make maps of the areas belonging to the State, the State Board of Education agrees to pay for such services out of other funds than those appropriated for this forestry work. It is also agreed by the State Board of Education that, when necessary, the services of Mr. Thompson and others now in the employ of the State Board of Education in connection with their swamp lands, shall be available.

The work shall be conducted and carried on under the direct supervision of the State Geologist.

The general plan of the work shall be:

To obtain as accurate a record as possible of the value of the lands belonging to the State so that on prepared maps of these areas the value per acre can be indicated as well as the character of the land.

The Forester appointed by the State Geologist shall have general supervision of the forest lands belonging to the State and shall, with the assistance of inspectors and others now employed by the State Board of Education, do all in their power to prevent timber stealing; shall make plans for cutting the timber when same is sold on stumpage; shall make plans for the prevention of forest fires; shall make plans and practical demonstrations of the cultivation of forests; shall draw up and carry out a plan for perpetuating certain forest areas according to definite and approved plans of the U. S. Bureau of Forestry; and shall investigate the diseases of trees and other problems that may be of benefit and value to forest lands.

By this arrangement, considerable work has been done during the past year in connection with the forestry problems that confront us. The first work taken up has been to determine the extent of the swamp lands of eastern North Carolina that are under the control of the State Board of Education and to determine their value. Plans have already been made for assisting owners of timber land in perpetuating their forests and making them more productive.

In connection with this work, seven different tracts have been examined in Bladen, Columbus, Camden, Onslow and Hyde counties. The county records of these counties, Bladen, Columbus and Cumberland, were examined and three tracts embracing about 300 acres of unsurveyed land of the State Board of Education were located in this way. Surveys have

been begun on land in Columbus and Bladen, while the survey of Holly Shelter swamp has been nearly finished. More than 300 letters were written in connection with the examination of these lands.

Four tracts of land have been examined and advice given the owners in regard to the methods of managing the timber. There are applications on file for the examination of three other tracts, aggregating nearly 40,000 acres; and for plans for planting cut-over pine land by a lumber company in Columbus County. These applications are the result of the offer of the Survey to assist owners of timber lands in the management of their properties. Considerable correspondence has been had with power companies in regard to planting waste lands on their properties which are subject to erosion and plans for planting will probably be submitted to some of these during the winter.

Another line of work that has also been undertaken is the reclaiming of barren and abandoned farm lands by planting them in trees. When it is considered that the forest area of North Carolina amounts to more than 10,000,000 acres, a very large portion of which is steep, rough or poor land which is not suitable for agricultural purposes and which, for many reasons, it is very essential should be kept in forests, it can readily be seen that the forestry work is very important to the State. This importance of the forests of North Carolina is strikingly shown by the fact that the forests and the industries dependent upon them produce material amounting in value to more than $35,000,000 a year, and give employment to 30,000 men. There are but few States in this country where the importance of the forests is relatively as great as in this State, where one-sixth of the entire wealth-producing capital is invested in forest lands or in industries directly dependent upon the products obtained from the forest.

The State of North Carolina recognizes that the furniture industry in the State is absolutely dependent upon a permanent supply of hardwood; that the tanning industry, if it is to become a permanent industry as it should, is dependent upon a constant supply of tanning material; and that the paper industry, which should also be a permanent one, is dependent upon a constant supply of pulpwood. The forestry department of the Geological and Economic Survey of the State believes that it is not only possible to make these industries permanent in the State and give them a constant supply of the woods that they need, but also to enable them to develop to a still greater extent.

Not only is it necessary that the present timber land not suited, when cleared, for agricultural purposes be kept as a perpetual forest, but also that the waste, or abandoned farm lands in the State should be re-

forested. There are approximately 2,000,000 acres of this waste land in the State which have either been lumbered and burned, or cleared for agricultural purposes and found unprofitable to cultivate on account of its roughness and the erosion to which it is subjected. This land represents idle capital of not less than $2,000,000. Instead of lying idle and producing nothing, it should be planted in trees, and thus become an area that will be constantly increasing in value.

In order that the Geological Survey may more effectively carry on its work in forestry, the following legislation is urged:

LEGISLATION RELATING TO THE PROTECTION AND PERPETUATION OF THE FORESTS OF THE STATE.

The General Assembly of North Carolina do enact:

CHAPTER —.

SECTION 1. That for the purpose of protecting the State's interests in its own land in eastern North Carolina under the control of the State Board of Education; for the re-forestation of waste and deserted lands throughout the whole State; and in order to be able to take up all problems relating to forestry in the State, the State Geological and Economic Survey shall employ a Forester and such assistants as may be necessary to carry out the provisions of this act.

SEC. 2. It shall be the duty of the Forester to acquaint himself with the extent and value of the lands owned by the State and under the control of the State Board of Education, and to make such recommendations regarding their care and sale, or sale of timber, as in his judgment will yield the greatest returns to the State. He shall also, under the direction of the Survey, make investigations relating to the re-forestation of abandoned farm lands throughout the State and demonstrate the practicability of such re-forestation. He shall, so far as possible, give advice and assistance to any county, city, or town regarding the planting and protection of decorative and shade trees within their borders; shall investigate ways and means for the prevention of forest fires which at the present time are destroying, each year, timber to the value of many thousand dollars; and shall investigate regarding the protection of the hardwood forests in western North Carolina. He shall make regular reports to the Survey of the work accomplished.

SEC. 3. The sum of $5,000 annually, is hereby appropriated out of any moneys in the treasury, not otherwise appropriated, for the purpose of carrying out the provisions of this act, to be drawn upon as directed by the Geological Board.

SEC. 4. That this act shall be in force and effect from and after its ratification.

Forest Fires.

One of the greatest evils that the State has to contend with in relation to forests is forest fires and, although there are certain fire laws in force in the State, they are not effective enough to prevent great losses each year by forest fires.

EFFECT OF FIRES ON THE FORESTS.

Eastern Counties.—One of the worst effects of the forest fires in eastern North Carolina has been the prevention of the long-leaf pine from reproducing itself. Large areas that were once covered with this valuable tree and which should now be reproducing another growth of the same kind are instead covered with sand oak or black-jack, which are practically valueless.

The loss to the people of this section from the burnings of these pine lands, taken in the aggregate, is enormous, as, but for the burnings, thousands of acres which are now denuded of all merchantable trees would either be covered with mature forests or with thick groves of young trees.

They have in many instances also destroyed the "bays" or swamps in which the white cedar or "juniper" grows, burning not merely all seed-bearing and young trees but the very soil as well, as it is usually peaty and contains a large proportion of woody matter. The hardwood timber in swamps has been less damaged, as the swamps only become dry enough to burn in the summer and fall, while the leaves are still green. Occasional fires, however, in exceptionally dry seasons do great damage.

Central Counties.—In the counties in the middle part of the State fires have done considerable damage in killing down young growth, but, as a general thing, except where there are large tracts of forest and the country is poor, rugged or thinly settled, the lands are not regularly burned and the damage that has been done to old trees is much less than in other parts of the State. These occasional fires, however, kill much young growth that has been several years growing and in this way keep the woods open.

Western Counties.—In the mountains, although there is a great deal of excellent hardwood timber, many of the trees which would otherwise be merchantable have been badly damaged by fire. The woods have been kept free from young growth by pasturage and frequent burnings. In places they are exceedingly open and there are no young trees at all to take the place of the old ones as they are removed.

About one-half of the forests in the mountains can be considered as consisting of original growth; the rest is either second growth, or has

been severely culled and consists of young trees, often largely coppice, that is, stump or roots, mixed with defective old trees. Once deterioration is fully under way, it proceeds rapidly. In many places fencing is obtained with difficulty, and the same is true of building materials.

Yellow poplars are decreasing, maples probably taking their place more largely than other trees. The white oak is not decreasing and in chestnut woods it is probably increasing. Scarlet oak is increasing, as is the chestnut oak in many places, though most of the young trees are stump shoots. Cherry, red oak and ash are decreasing. Locust is increasing, particularly around farms. Yellow birch, maples, beech and buckeye are increasing on northern slopes.

DAMAGE TO TREES BY FIRES.

Fires certainly do more damage to the pine and hardwood forests of the middle and western counties of this State than any other one, or possibly, than all other agencies. Except in the dampest woods of the higher mountains, there is scarcely a piece of woodland to be found which does not show traces of damage caused by them. The damage to standing timber is considerable, but it is doubtful if, on the whole, it is nearly so large as that to the young growth, which ought to be growing, or ought to have grown, to take the place of the old trees as they are cut or die.

CAUSE OF HOLLOWS IN TREES.

The greater number of hollows in immature and undersized chestnuts, yellow poplars and oaks, and in many other trees as well in the middle and western counties were caused, either directly or indirectly through fires, and it is likewise probable that the hollows far up the trunks of many of the larger trees are due to this cause.

Particularly in the early spring when the sap is rising and the trees beginning to grow, fires are apt to scorch small spots at or near the base of trees, which will kill the cambium or growing layer beneath the bark. The bark over the scorched place either falls off or becomes loosened. If it falls off the tree presents on its surface a layer of dead sapwood or of the growing tissue. This layer is rich in food materials, having been active and filled with sap when killed and is at once attacked by insects which channel the wood in all directions, or deposit their eggs and their grubs which hatch out and make openings in securing food. If the bark does not fall off, it will take longer for the insects to make their way beneath the wood. Through their openings thus made, air and water will enter, bearing the germs of rot and disease, or the insects may bring them in upon their bodies, and so, without the bark falling at all, the entire

base of the tree may become decayed, or even hollow within and show no signs of it from without.

When the bark falls after a tree has been scorched by fire, open hollows will be formed and subsequent fires will often aid in extending them up the trunk of the tree.

FINAL RESULTS OF FOREST FIRES.

The burning of the woods, begun in some places a great many years ago and constantly repeated, has seriously interfered with the natural growth of the trees. Many of the tender kinds have become less abundant, as is the case with the long-leaf pine, while hardier kinds, which from their thick bark or the ease with which they sprout form the stump, roots, or at the base of the tree, have managed to survive and even increase as their competition with other trees was lessened. In the mountains both the chestnut and the chestnut oak have maintained themselves where trees that sprout less vigorously from the stump have perished. Their persistence, however, has been due to their ability to sprout from the stumps or roots and not from new seedling plants. In the middle part of the State the black-jack oak is in many places following black oaks and pines; in other places sourwood from seedlings and suckers is increasing at the expense of more valuable trees.

Besides influencing the kinds of trees, only those which are hardiest maintaining themselves, fires affect to a large extent the natural development of form in the individual trees. The growth is kept open, the crowns of the trees not interlacing as they should to insure proper development; height growth ceases at the expense of rapid enlargement of the trunk; and great crowns or tops are formed. Short-bodied timber, with many knots in the upper part of the stem, is the result, lessening, of course, the strength and timber value of the piece. The stems of hardwood trees are often crooked from the same cause, and where two or more shoots come up from the roots of a small tree, the top of which has been killed, not infrequently both of them will fail to make trees of value. Even where the hardy trees succeed in securing a foothold, it is sometimes only after having been killed down several times that they reach maturity several or many years later than they should and delaying the final yield of the product by so many years. The total amount of woody material grown in thin woods is much less than if the growth was kept thick and reduces the amount of salable timber from the forests by just so much.

Continual burning injures the soil by leaving the humus, leaves, etc destroyed and the ash washed off by rains.

To sum up: When the woods are burned, the final yield is less; the timber reaches maturity after a greater number of years; there are more defective trees; the timber is not of so good a quality; hardy kinds are propagated at the expense of tenderer kinds which often have a greater timber value.

In order to more effectively prevent forest fires and thus protect our timber supply, I would earnestly urge that the following legislation relating to the protection of forests from fires be enacted.

Legislation to Protect the Forests of North Carolina From Fire.

Chapter —.

The General Assembly of North Carolina do enact:

Section 1. That Section 3324 of the Revised Statutes be changed to read as follows: If any person shall set fire to any grass land, brush land or any woods except it be his own property, or, in that case without first giving notice in writing to all persons owning or in charge of lands adjoining to the woodland or other land intended to be fired, at least two days before the time of firing such lands, and also taking care to watch such fire while burning and taking effectual care to extinguishing such fire before it shall reach any lands near to or adjoining the land so fired, he shall, for every such offence be guilty of a misdemeanor and be punishable by a fine of fifty dollars, one-half to go to the person who brings the suit and one-half to go to the State Treasurer to be used for forest protection. This shall not prevent action for damages sustained by the owner of any property.

Sec. 2. That Section 3325 of the Revised Statutes be changed to read as follows: Any wagoner, hunter, camper or other person who shall leave a camp fire without fully extinguishing it, or who shall permit any accidental fire from any torch, gun, match, or other origin to burn in any grass or woodland without fully extinguishing it, shall be guilty of a misdemeanor and shall be punishable by a fine of fifty dollars, one-half to go to the person who brings the suit and one-half to the State Treasurer to be used for forest protection.

Sec. 3. Every person or company operating a locomotive or logging engine in this State shall equip the same with a spark arrester of a character and condition approved by the Corporation Commission and any person or company who operates one not so equipped shall be subject to a fine of one hundred dollars for each such offence, one-half to go to the person who brings the suit and one-half to the State Treasurer to be used for forest fire protection.

SEC. 4. Forest Wardens or any agent of the State may recover from owners or operators of locomotive by a suit in court the cost of extinguishing or controlling any fire which originates from their locomotive, and any money so collected is to be repaid to the county and State pro rata accordingly as they contributed to the expense of extinguishing the fire. Such recovery shall not prevent action for damages by owners of property which has been injured.

SEC. 5. Four or more owners of timber lands in any one township, or the owners of one-third of the forest land in the township, can petition to the State Forester for the appointment of a Forest Warden for that township and, after such application, a Forest Warden may be appointed by the Governor to serve at his discretion and such Deputy Wardens as may be deemed necessary can be appointed by the State Forester to act with the warden in any such township.

SEC. 6. Wardens shall have charge of measures for controlling forest fires; they shall make arrests for violations of the forest laws; shall post copies of the forest fire laws and warnings against fires which shall be supplied by the State Forester; and they shall perform such other duties as shall be considered necessary by the State Forester for the protection of forests.

SEC. 7. All able-bodied male persons between 18 and 40 years of age can be summoned by Forest Warden or Deputy Warden to assist in extinguishing forest fires, but no person can be compelled to serve more than two days in any year. Persons shall be paid for their services in extinguishing fires at the rate of ten cents per hour, and the total amount which may be expended in any one township shall be limited to fifty dollars in one year. Any person summoned by a warden or his deputy and not attending, without sufficient excuse to the warden, shall be subject to a fine of five dollars in a suit brought by a warden or deputy before any magistrate.

SEC. 8. No landowner can be compensated for services rendered under this act in extinguishing any forest fire on his own land; nor can any employee of any person or corporation receive compensation for such services in controlling fires on the lands of his employers.

SEC. 9. Forest Wardens and their deputies shall have the same powers as deputy sheriffs so far as the provisions of this act are concerned. Neither Forest Wardens nor their deputies shall be liable for trespass while acting in the performance of their duties, nor shall any person be held guilty of a trespass for going on land when summoned by an officer to control a fire.

SEC. 10. Forest Wardens and their deputies shall be paid at the rate

of fifteen cents an hour for the time actually engaged in the performance of their duties, according to an itemized statement rendered the Forester every month and approved by him, out of any moneys in the State Treasury not otherwise appropriated. Persons summoned by wardens shall be paid upon vouchers signed by wardens and approved by the State Forester, three-fourths of the amount being paid by the State Treasurer out of any moneys not otherwise appropriated and one-fourth being paid by the County Treasurer out of the county funds of the county in which the fire originated.

Appalachian Forest Reserve.

The question of an Appalachian Forest Reserve has been given considerable attention and consideration by the State Geologist, and he has gone to Washington several times as a member of committees to appear before the Speaker of the House of Representatives regarding the passage of the bill relating to the establishment of the Appalachian Forest Reserve.

In investigating the necessity of establishing this Forest Reserve, the President's Conservation Commission, consisting of Hon. Charles F. Scott, of Kansas, Chairman of the Committee on Agriculture, Senator Reed Smoot, of Utah, Professor H. S. Graves, Director of the Yale Forest School, and Mr. William Irvine of Wisconsin, together with W. L. Hall of the U. S. Forestry Department and Joseph Hyde Pratt, State Geologist, made a trip through portions of the mountain sections of North Carolina and Tennessee. Stops were made at Toecane, Mitchell County; Johnson City, Tenn.; Asheville, Buncombe County; Waynesville, Haywood County; and Balsam, Jackson County. On this trip it was possible to show the Commission the final results that can be expected if the forest areas of the mountain sections of western North Carolina are cleared. Some areas were noted where all the soil had been eroded, leaving the hillsides barren and unproductive and illustrating very completely why the streams rising in the vicinity of these badly eroded hillsides were subject to heavier freshets and longer periods of low water than formerly.

Sand Banks and Dunes.

During 1907, an examination was made of the sand banks along the North Carolina coast to determine in a general way the damage that was being done by drifting sands on the area examined and also to enable the Forester to recommend methods of protection against further damage. The results of this examination, which was made by Mr. J F. Bond, Forestry Assistant of the U. S. Forest Service, are given below:

REPORT ON AN EXAMINATION OF THE SAND BANKS ALONG THE NORTH CAROLINA COAST.

By JAY F. BOND, Forest Assistant, U. S. Forest Service.

INTRODUCTION.

The following report is the result of a brief examination of the banks off the North Carolina coast between Cape Hatteras and the wooded area about six miles west of Beaufort Inlet. This investigation was undertaken by the Forest Service at the request of the State Geologist of North Carolina and was intended only to determine, in a general way, the damage being done by drifting sands on the area examined. If considered necessary, methods of protection against further damage were to be recommended.

The portion of the banks covered by this report is typical of the entire strip and within this area are the only places where active protective measures seem to be required at the present time. A detailed plan for the treatment of these lands is included in this report.

DAMAGE BY SHIFTING SANDS.

There is abundant evidence, throughout the area examined, of marked changes within a comparatively recent time. Within the recollection of many of the present residents, practically the entire banks were forest covered. At present, however, the forests occur only at two points. Immediately west of Cape Hatteras are approximately 2500 acres covered principally with loblolly pine. Recent estimates of the amount of pine in this stand approximate 20,000,000 feet board measure. Although this figure seems excessive, there is undoubtedly a considerable amount of valuable timber in the forest. The trees are of medium size and the lumber of relatively low value, but the accessibility of the stand and the great market for even the poorer grades will make the exploitation of this timber profitable. These lands are held by private owners and the stumpage is controlled by a company which holds an option at $.50 per thousand feet, B. M. This option expires January 1, 1910.

Poor business management has caused a suspension of logging operations, but it is practically certain that lumbering will be resumed in the near future and that a considerable portion of the forest will be removed before the expiration of the option, since it could be renewed only at a much higher rate.

Near the western end of Shackleford Banks are a few hundred acres of forest composed almost entirely of red juniper. This is being exploited in a small way for posts.

The entire area between these points is barren and unproductive. Only at the villages of Hatteras and Ocracoke where the residents maintain small gardens is there any attempt to utilize the land in any way except for the pasturage of a small number of stock. Sand more or less fixed in the form of dome-shaped dunes extends from the ocean to the sounds. The damage here is complete and the improvement of the area as a whole is practically impossible.

There are two localities on the area under discussion where protective measures would prove a decided benefit. At the southeastern and southern part of the woodland near Cape Hatteras the blowing sand is rapidly encroaching upon and destroying the forest while at Beaufort Inlet the surface

sand is being blown into Core Sound and, through the destruction of the beach, the width of the inlet is perceptibly increasing. The problem of arresting the damage at these two points is discussed in detail below.

CAPE HATTERAS FOREST.

Along the entire southern and western edges of the forest west of Cape Hatteras a considerable area of woodland is being buried and destroyed by blowing sand. As stated above, this timber has a distinct value and, in addition to its value for lumber, the occurrence of the forest makes this locality by far the most desirable residence section of the banks. It is simply a question of a rather limited time, however, when the encroachment of shifting sands, together with destructive logging, will complete the permanent denudation of the area.

The greatest difficulty to be encountered in the treatment of these lands is the fact that they are private property and therefore can scarcely be controlled by legislative action. Apparently nothing can be done, except in an advisory way, to regulate the exploitation of these woods. Fortunately, however, the logging operations were begun at the sound side of the forest and farthest remote from the area being encroached upon by the sand and hence the cut-over area will have an opportunity to reforest naturally before the removal of the timber immediately in the lea of the approaching sand dunes. The large proportion of loblolly pine in the stand makes reproduction certain with a minimum of protection. It is certain, however, that by far the greatest factor in the destruction of the original stand has been careless lumbering.

The destruction resulting from logging has been made permanent by unrestricted grazing. Cattle, sheep, goats and hogs have free range and the damage from these sources cannot be over-estimated. Hogs are the greatest menace and a single hog, practically valueless, will root out large areas of sand-binding grasses along the beach. Cattle and sheep complete the destruction by eating the roots of the uprooted grass. The sand thus liberated is carried away by the wind and a "blow-out" results. This "blow-out" constantly enlarges until the damage becomes general and large areas are affected.

Even if grazing were an important industry on the islands, free range of stock would be fatal to the industry itself as well as to the general productiveness of the lands. The reverse is the fact, however, since competent observers place the total value of all stock between Cape Hatteras and Hatteras Inlet at no more than $1000. The cattle, sheep and horses are in-bred and of minimum value while the hogs are practically worthless, since the meat is unfit for consumption, owing to the carrion fish upon which they feed.

It is strongly recommended, therefore, that the State Legislature enact suitable laws providing for the fencing of all stock upon this portion of the banks. This will work no real hardship upon stock owners and, moreover, is an economic necessity if the industry be made profitable. Without such legal protection, all measures for the control of shifting sand such as are described below will be useless. In addition, natural reproduction on the cut-over forest areas cannot be satisfactory since, under present conditions, live oak reproduction, which would otherwise be abundant, is missing and even pine reproduction is very seriously damaged.

The sand-dune area which is encroaching upon the forest lies to the south and east of the woodland. Beginning at a point two miles east of Creed's Hill Life Saving Station, it extends westward four and one-half miles and beyond the wooded area where the sand extends entirely across the banks to the sound. A description of this area and certain recommendations appear below.

CAPE HATTERAS SAND-DUNE AREA.

The moving sand of the dune area between the forest and the ocean has already covered up and destroyed the growth for about one-half mile inland. At the western end of the dune the sand gradually slopes into a low marshy area which extends to Durant's Life Saving Station where a small body of live oak occurs. To the south of this woodland is a long, narrow sand dune and to the west a low wash-flat extends to Hatteras Inlet where there are a few mound-like dunes near the beach.

It is only the dunes immediately south and west of the Cape Hatteras forest which are discussed below, since the dunes further to the west can do practically no damage. Over this entire area the sand is constantly moving in a northeast direction. The surface is practically bare of vegetation and such growth as does spring up from time to time is promptly destroyed by stock.

The direction of the movement of the dunes is undoubtedly influenced by the forest growth which shelters the area from the northerly winds. From the south the winds have uninterrupted sweep and, in consequence, the sand is carried by these winds in a northerly direction. The prevailing winds in the different seasons also have a greater or less influence on the direction in which the sand is carried. During the summer the sand becomes very dry and in this condition is easily carried by the winds which are southerly at this season. In the winter, however, the moist condition of the sand prevents it from being easily carried by the northern winds which prevail. The result is that even where the winds have full sweep in both directions the general movement of the dunes is toward the north.

At the northern end of the sands the dunes terminate abruptly at the edge of the woods. Here there is a high dune rising gradually to a height of about 25 feet. To the leeward the slope of the dune is fully 35°, which seems to be as steep as sand will remain at rest.

The rate at which this dune is advancing inland could not be determined in the short time available. It is very evident, however, that the advance is relatively rapid, since there are numerous living tops of trees protruding above the sand considerably to the windward of the crest of the leeward dune.

To control and fix these sands will require most careful treatment and an expense entirely disproportionate to the value of the reclaimed land and of the forest lands in the lee. So long as the present conditions in respect to laws and the ownership of the greater part of the area exist, protective measures are impossible. In addition to the enactment of stock laws as recommended above, it is recommended that the State acquire by purchase a strip of the forest land in the lee of the dunes not less than 500 and preferably 1000 feet wide and extending along the entire area so far as the forest occurs. When this has been done the active measures looking to the control of the sands may be put into effect.

THE FIXATION OF THE SANDS.

The permanent reclamation of the sand waste depends upon two things: (1) Since the source of supply of the sand is inexhaustible, a barrier must be provided near the beach to prevent new supplies of sand which are brought up by the surf from being blown inland. (2) The loose moving sand in the lee of this proposed barrier must be permanently fixed by growing forests.

The success of all work relative to the satisfactory growth of the trees and consequent binding of the sand depends upon the barrier and past experience has established that this barrier is most satisfactory, if it consists of a littoral dune of proper height built up by sand which is arrested by means of mechanical obstructions and held in place by suitable sand-binding grasses. It should be built up parallel to the shore line and not nearer than 100 feet to high-water mark.

When the work of fixation is complete, the entire area, with the exception of the strip between the barrier dune and the shore line, will be covered by a forest. The strip to the windward of the barrier must be held in place by the planting of grass. When the forest has been established, it should be cared for according to usual forest practice.

It will be impossible to establish a forest directly upon the drifting sand either by sowing the seed or by setting out young trees, since the blowing sand either uncovers the seed or buries it too deeply, while in the case of planted trees, the sand cuts the leaves and bark or buries the plants. It will therefore be necessary to hold the sand in place by some mechanical covering until the trees have developed and formed a natural cover.

The work of fixation is thus divided into two stages: (1) Preliminary, holding the sand in place. (2) Permanent, establishing a forest. Upon the coast strip the work never proceeds beyond the first stage and the maintenance of a grass cover will require constant care.

THE COAST STRIP AND BARRIER DUNE.

The coast strip and the barrier dune should be handled in such a way that the surface of the strip may not jeopardize the stability of the dune. It is obvious that the first work is the proper formation of the dune. This is done by rapidly accumulating blowing sand so as to form a long ridge. For this purpose, palisade fences arranged in a double row 6 feet apart are used. Each fence should be made of inch boards 6 inches wide and 5 feet long, driven about 2 feet into the sand. The tops of the fences should be of equal height and the palings should be four inches apart. Such an arrangement of fences allows the wind to pass through, but reduces its velocity and hence sand is deposited within and on both sides.

As the sand accumulates to the tops of the fences, the palings should be raised and, when the dune has reached a height of 30 feet, sea oats (*Uniola paniculata*) should be planted 3 feet apart, alterating in rows 3 feet apart, parallel to the crest of the dune. The grass should be planted on both sides of the dune and gradually extended toward the windward until the dune attains a fairly permanent form with a gradual slope to the windward, while on the leeward side the slope will be approximately 30°. The successive steps in the formation of the barrier dune is shown in the series of diagrams accompanying the report. (See Plate II.)

The barrier dune, when completed, will protect the area in the lee but will require constant care to keep it in proper condition. Every precaution should be taken to prevent a break in the dune and, if such occurs, it must be repaired immediately, since the wind will constantly enlarge the opening. A break may be repaired by the simple expedient of piling brush on the surface of the "blow-out" and, when the sand has filled in to its former level, by replanting grass as before. The main care should be to maintain a good grass cover over the dune and the coast strip. When the grass becomes thin in one place, plants should be taken from areas where it is thicker than necessary and replanted where required.

FORESTATION.

The area in the lee of the littoral dune must be planted in forest trees to accomplish permanent fixation. Local conditions and geographical position of the area to be planted are such that proven methods developed in extensive work of this character in Europe may be adapted to this project.

It has been established that the most certain method of securing a forest cover on waste sands is by direct sowing of the seed, provided that suitable species are available for use in the locality and also that the sand be temporarily fixed until the young trees are well established. Upon the formation of the barrier dune the sands in the lee will be comparatively free from the action of the wind, since the dune will protect the area from the southerly winds, while the forest will serve as a windbreak to the north.

Loblolly pine, a rapid growing species which produces valuable timber, grows throughout the banks. Although, owing to the exposed situation, the quality of timber produced cannot equal that of the forests of the mainland, this tree is by far the most desirable commercial species on the banks.

The proper method of sowing the seed can be determined only by experiment. Two methods are suggested, the second to be used only when it has been clearly demonstrated that the first is not feasible. (1) Sowing the seed directly on the surface. (2) Sowing the seed after the sand has been temporarily fixed by a light covering of brush.

At the western end of the shore dune, on a strip 500 feet wide and extending from the dune to the forest, loblolly pine should be sown at the rate of 12 pounds per acre. The seed should be sown directly on the surface of the sand without any preparation of the site. Although there is good reason to count upon favorable results, there are several possible objections to this method. Large quantities of the seed are almost certain to be destroyed by birds and to guard against this the seed should be coated with red lead before being sown. Again, wind will blow away some of the seed and in other cases will cover the seed too deeply with sand. It is certain that the action of the wind will be greatly reduced by the littoral dune and the forest, but just how efficient this shelter will be can be determined only by actual experiment.

It is obvious that if the sweep of the wind over the area in the lee of the dune is not reduced to a minimum, the success of planting by direct sowing without previous preparation of the site will be impossible. In such a case the surface of the area to be planted must be covered with a light covering of brush, laid in rows parallel to the barrier dune. Seed should then be sown at the same rate as above among the brush.

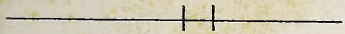

Fig 1

Fig. 3

Fig. 2

Fig. 4

Fig. 5

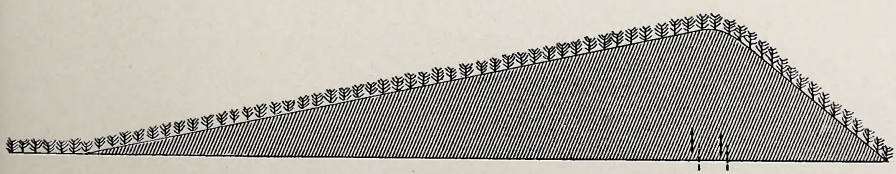

Fig. 6.

DIAGRAMS EXPLAINING PROGRESSIVE STEPS IN THE FORMATION OF BARRIER DUNE

When the dune has assumed the form illustrated by Fig. 4, grass is planted, and by extending the area planted towards the shore (to the left) the subsequent form of the dune is influenced.

Such a method, although more expensive than the first plan, will insure success. The brush should be allowed to remain until the young trees are established and the year following the sowing it should be removed in order not to interfere with the growth of the seedlings.

Brush can be obtained from the nearby forest. Myrtle, red bay, yaupon, or any similar material may be used. Brush cut from the tops and limbs of conifers after lumbering will serve admirably. Such material may be obtained from recently cut-over areas in the forest.

The forest immediately in the lee of the sands, the purchase of which has been recommended above, should be carefully conserved. Absolutely no cutting should be permitted until the dune forest is firmly established.

The expense of fixing the sands can be only approximated. There was no opportunity in the limited time available to determine the rapidity at which the barrier dune would accumulate. It is obvious therefore that the cost of the dune cannot be determined, since it will vary directly with the length of time which will elapse before it assumes permanent form. The cost of forestation can, however, be approximated, and will vary from $25 to $40 per acre, depending upon the method. Seed of the loblolly pine are quoted in the market at $2 per pound but could undoubtedly be secured by contract at a much lower figure. Material for the palisade needed in the building up of the barrier dune represents a first cost of $900 at present prices and labor for its construction will add at least $500. The cost of maintenance cannot be predicted.

Grass planting on the coast strip and the littoral dune will be expensive and at least $500 must be allowed for this work exclusive of maintenance.

The entire cost of the work of fixation, exclusive of any expense necessary in the acquisition of the lands, will reach at least $40,000.

ADVISABILITY OF PROJECT.

This report does not aim to outline a policy. It merely suggests a definite plan by which the areas under discussion can be protected and leaves the advisability of the action to the proper authorities.

The work of fixing the sands will serve to accomplish the perpetuity of the only forest remaining on the banks above Beaufort Inlet. If prompt measures, such as outlined above, are not taken, the destruction of the forest is certain. The lands will become a sand waste similar to the larger part of the area of the banks. The cost of the work, however, is large and it is doubted if the value of the property to be protected will equal this cost.

Aside from the intrinsic value of the property, it must be considered that this area supports a considerable population which will be seriously affected should the land become waste. These people are entitled to protection by the State and, although relief could be secured by temporary measures involving less immediate expense, the method of treatment recommended necessitates the lowest cost consistent with permanent protection.

If, however, the project is undertaken, it is strongly advised that the work of carrying out the details of the general plan advised be entrusted to a competent official and be made a part of his duties.

THE BEAUFORT INLET PROJECT.

The Department of War maintains a series of sand fences on either side of Beaufort Inlet at the entrance to the harbor. These fences are to hold the sand as it is brought to the beach, in order to build up the beach and prevent the inlet from increasing in width. The effect of the blowing sand which might be deposited in the channel is not considered, since the currents will serve to keep the channel clear.

Since the Department of War has made provision for the continuance of this protective work, a further discussion is not essential.

However, if the State takes up the work outlined in this report, it is suggested that the proper official keep in close touch with the work at Beaufort Inlet.

Forestry Publications.

A number of publications have been made relating to forestry during the past two years. One was on Shade Trees for North Carolina, which was published as Bulletin No. 16. In the publication of this report it is the desire of the Geological Survey to arouse within the State a more thorough appreciation of the necessity and beauty of shade trees on the streets of our cities and towns. To this end, descriptions are given of the majority of the shade trees suitable for street and park planting in different sections of the State and illustrations have been used to show more effectively the advantages to be derived by a town or city through the judicious planting of suitable trees on their streets. Many towns now realize that shaded parks and streets bordered with neatly kept rows of trees are an asset of very great value. In many instances where a town is without such shade trees it has begun to plant them and the present bulletin will be of considerable assistance to such towns in the selection of the proper trees for planting, the suitable time of year to set them out, and how to care for them and protect them from disease and insects. Various combinations of trees that grow well together and harmonize with each other are given and also suggestions regarding combinations of trees to give pleasing effects of color in the spring when the trees are flowering and in the fall when the foliage is turning. To the person who is interested in tree planting for his own yard, the bulletin should be of some considerable value inasmuch as it goes into detail in regard to the transplanting and pruning of trees.

A short chapter is devoted to Arbor Day and it is hoped that the bulletin will be the means of promoting a more general observance of this day in the State, especially in the public schools, which will thus inculcate in our school children a love for our trees, and as they grow up, they will appreciate not only their beauty but also their real value to the place in which they may happen to live. One of the customs of Arbor Day is

the planting of trees and, if but a few trees are planted each year by each school throughout the State, it will mean that a great many portions of the State will in a few years show most strikingly the advantage of systematic planting.

Another bulletin that is in manuscript form and ready for the press is on The Loblolly Pine in Eastern North Carolina. This bulletin will give a large amount of data and information relating to the rate of growth of the loblolly and other pine trees, together with suggestions regarding re-planting of lands in pine trees.

The Forester has also prepared a series of Press Bulletins relating to Forestry that have been published from time to time and are widely distributed throughout the State. In this work of disseminating information regarding our forest lands and their value, we have had the hearty co-operation of the press of the State who have very generously published the various articles in whole or in part that have been sent out as Press Bulletins. This publicity cannot but help to interest the people of North Carolina in the preservation of our forests so that the industries dependent upon them will be permanent and not temporary enterprises in our State.

Twenty-one lectures were also made by the Forester in as many different counties in the State.

Terracing of Farm Lands.

One result of the clearing of forest areas is that erosion is more rapid and, if the land is not protected, erosion will extend rapidly on the slopes of our hills until in some instances all the soil will be entirely washed away, leaving the slopes indented with deep gullies. A study has been made of such conditions in the Piedmont section by the Forester and the results of this investigation have been published as Bulletin 17, on Terracing of Farm Lands. This subject is one that should be more seriously considered by the farmers of North Carolina, especially in this Piedmont section. This is one of the methods that can be satisfactorily employed in conserving this soil. For certain sloping farm lands no better or cheaper means can be devised. Where attempts have been made to utilize terracing methods and these have not resulted as favorably as expected, it has usually been that sufficient care and attention were not given to the location and construction of the terrace. They have been either too far apart or had too much grade on their upper sides. These points are carefully discussed in the report and it is hoped that this report will be the means of creating a more general use of terracing in the Piedmont section.

MAGNETIC SURVEY.

Since the establishment of the magnetic survey in North Carolina, which was begun in 1898, the stations are being re-occupied in order to determine the changes in the declination. During the past two years two stations were re-occupied and one new station established. The new station is at Goldsboro and takes the place of the old station at that point which was found unsuitable for future magnetic work. The new one is in the southern part of the City Park, about one mile southeast of the center of the town and about 255 feet a little east of south of the Park shelter house. It is 50.3 feet from the edge of the east brick border of the road to the west which runs south from the main gate and 134.7 feet from the fence on the south border of the Park. The station is marked by limestone posts 6 x 6 x 30 inches, projecting four inches above the ground and lettered U. S. C. & G. S., 1908. The following true bearings were determined: From north corner of tower of Wayne cotton mill ....42° 53′ W. of N. From north cupola of Dawson home.....50° 4.5′ W. of S.

The following are the magnetic observations that were made in 1907-08. There is also given the early observations at the same points.

MAGNETIC OBSERVATIONS AT NORTH CAROLINA STATIONS.

Station.	County.	Date.	Declination.
Roan High Bluff.	Mitchell.	May 17, 1907.	1° 26.9′ E.
Goldsboro (old station).	Wayne.	March 2, 1908.	2° 18.6′ W.
Goldsboro (new station).	Wayne.	March 4, 1908.	2° 13.3′ W.

EARLY OBSERVATIONS AT NORTH CAROLINA STATIONS.

Station.	County.	Date.	Declination.
Roan High Bluff.	Mitchell.	September, 1894.	0° 33.4′ E.
Goldsboro (old station).	Wayne.	May 25, 1899.	1° 50.3′ W.

A complete list of declinations of North Carolina observations at county seats are given in the reports of the U. S. Coast and Geodetic Survey for 1898-1899 in a separate, known as Appendix No. 9.

FISHING INDUSTRIES.

At the session of the legislature of 1907 an act was passed creating the Fish Commission of North Carolina whose work was to be under the supervision of the Geological Board. This has meant that the State Geologist has had to give considerable time and attention to the work of this Commission and he has also audited all its accounts.

Unfortunately, however, for the obtaining of the best results from the work of the Fish Commission, the jurisdiction of the Commissioner is

restricted, as the following counties were exempted from the bill: Beaufort, Camden, Carteret, Craven, Currituck, Hyde, Jones, New Brunswick, New Hanover, Onslow, Pamlico and Pender. One unfortunate result to the State from having these counties exempted from the jurisdiction of the Fish Commission is that the U. S. Bureau of Fisheries cannot consider co-operation with those counties exempted from the bill, the position the Bureau takes being that if a county is not willing to do all it can to have the laws relating to fish and fisheries enforced, that the U. S. Bureau of Fisheries cannot afford to spend its time and money in trying to build up an industry while the people are tearing it down. The Geological Survey and the Fish Commission have received the most cordial co-operation from the Bureau of Fisheries in connection with their work. By means of this co-operation it was possible to make a careful survey of Chowan River, Albemarle, Croatan and the eastern portion of Pamlico sounds and thus have marked out the restricted areas relating to fishing. This survey was made by Mr. W. F. Hill and, while it was preliminary, it accomplished the results desired. It is necessary, however, that a permanent survey should be made and the restricted areas marked with buoys. In order to do this work, Mr. John H. Small, Congressman of the First District of North Carolina, introduced a bill into Congress asking for $15,000 to carry out this work. This bill will be taken up at the short session of Congress.

It was considered advisable to hold another Fish and Oyster Convention and the Governor, as Chairman of the Geological Board, called this meeting to be held on August 26 and 27, 1908, at Morehead City. At this convention the present fish and oyster laws were carefully considered and new legislation recommended which the committee believed necessary for the preservation of the fish and oyster industries of the State. The deliberations of this convention have been published as Economic Paper No. 16, and I would call especial attention to the suggestions of this convention regarding general legislation relating to the cultivation of the oyster and clam; to the protection of the terrapin; and to an early closing season for shad and herring.

Oyster Cultivation.

The results of the investigations that have been carried on relating to the cultivation of the oyster by Messrs. R. E. Coker and H. D. Aller, have been published as Bulletin No. 15, on Experiments in Oyster Culture in Pamlico Sound, North Carolina. Experimental oyster beds had been made and kept under constant observation for three to six years, notes having been taken regarding the density of the water, number of diatoms

it contained, growth of the oyster, etc. These experimental plants have for the most part been very successful during the time in which they have been made and to some extent cultivated, and they indicate that there are large areas in Pamlico Sound that are suitable for the cultivation of the oyster and that this can be done profitably. The report describes in the greatest detail the methods employed in making the plantings in order that the results obtained may be profitably used by those who wish to take up the cultivation of the oyster. It is hoped and expected that the results of this investigation will be the means of awakening new interest in oyster culture in North Carolina and that large areas of the bottom of Pamlico Sound will be entered for this purpose. It is necessary, however, that some such legislation as has been recommended by the convention relating to the cultivation of the oyster shall be passed by the legislature, if this cultivation is to be taken up.

Clam Cultivation.

An investigation has been begun by Mr. Howard E. Enders, of Perdue University, in connection with the work of the Beaufort Laboratory, on the cultivation and propagation of the common clam, *Venus mercenaria*. In describing the work accomplished, Mr. Enders reports as follows:

The problem was approached in four ways: (1) By an attempt to raise young clams from the eggs; (2) by systematic towings; (3) by means of a device for catching "spat" and causing it to settle where the bottom seems favorable to the growth of clams; (4) noting the distribution and habitat of young clams in the harbor.

It was possible to fertilize the eggs in considerable numbers throughout July and August by stimulating them by means of various chemicals before the sperm was added. In spite of the large number of eggs that were thus fertilized, a comparatively small number passed beyond the four- and eight-celled stages, and still fewer reached the veliger stage. This is in large part due to the presence of a few fully-developed, or ripe eggs, together with many unripe eggs in the gonad. This number of ripe eggs increases rapidly when the animals are kept in captivity in well aerated water, but at no time were any eggs extruded by the animals in captivity in the laboratory tanks.

The towings during July yielded variable numbers of young free-swimming lamellibranch mollusca with well-developed shells ¼ millimeter long. They were provided with two adductor muscles for closing the shells. These shells are of the same shape as in older clams. The foot was small so long as the young clams were free-swimming, but as the animals change their habit to burying, the foot and siphon became conspicuously developed.

The tendency of the free-swimming young clams from the towings to retract the velum and settle to the bottom of the vessel as a result of an irritation led me to believe that a device such as the Japanese use in oyster culture would yield results as a "spat catcher." Accordingly, a square enclosure of

planks (9 x 9 feet) was constructed at the edge of a shoal near the laboratory. A portion of one side was open so that water might enter freely with the change of tide, and its height was such that the high tide swept over it. Branches were set in the bottom of the hollow square so that their tops extended beyond the top of the enclosure. No clams were found within this enclosure at the time it was constructed but four weeks of exposure to the tides during August yielded a dozen young clams (*Venus mercenaria*) which ranged in size from 2.1 to 5.0 millimeters in length. The sandy bottom of the enclosure had become covered with a thin layer of diatomaceous mud much like that found over many of the clam beds of the vicinity.

Young clams were found quite generally distributed throughout the inner portion of the harbor. (The young clams were collected by means of a fine sieve whose meshes were 1.5 millimeters square.) They are most abundant where the currents are not strong; coarse sandy shores did not yield any young animals. Clams which varied in size from 1.7 to 11.0 millimeters in length were found early in July. This diversity in size continued through August when they were collected in sizes from 2.0 millimeters upward to 18.0 millimeters in length, the average being about 5 millimeters. Collections were made from the same areas at intervals of several weeks to determine the rate of growth of the young animals in the first season.

The breeding season of *Venus mercenaria* extends through several months when a small number of eggs is discharged at short intervals under natural conditions; therefore the attempt to rear the young from the eggs in large numbers is not feasible.

Fishes of North Carolina.

A report that has been very favorably received and I believe has been of great value to the fishing interests of the State is on the Fishes of North Carolina, prepared for the Survey by Dr. Hugh M. Smith, Deputy U. S. Commissioner of Fisheries. The report has been prepared to meet the numerous inquiries that are constantly being received by the Geological and Economic Survey concerning the fishes found in the different waters of the State. It has been the desire of the State Geologist to awaken an increased interest in the local fishes, and to give to the people of North Carolina and to others a more accurate knowledge of the abundance, distribution, habits, migrations, spawning, food value, etc., of the fishes, in the belief that such knowledge will lead to a fuller realization of the economic importance of the fishery resources of the State. It is desirable also that there be created a deeper interest in the welfare of both fishes and fishermen, and a better understanding of the condition and needs of the fishing industry, with a view to placing this important branch on a permanent basis and making it yield an increasing revenue to both State and people.

In this report there is an account of every fish that has been ascertained to inhabit the fresh, brackish, or salt waters of North Carolina. All

local names by which the fishes are known are recorded, and diagnostic descriptions are given that are often based on local specimens. Colored plates or text cuts representing a very large number of the species have been provided. While the chief aim in preparing the report has been to make it of practical usefulness to the fishing interests, the scientific aspects of the subject have not been neglected and the work will be found to have a value to ichthyologists and to zoölogists in general.

The report is particularly useful in that it affords a means of identifying any fish that may be taken in State waters. The artificial keys are based on external characters that commercial fishermen and anglers may readily appreciate; and the copious index of common names gives a further clue to all the species whose size makes them objects of capture.

It is hoped that this volume will be the means of creating such an interest in the fisheries that suitable laws for their protection may be enacted as needed, and that the State officers charged with the administration of the fisheries may have the sympathy and co-operation of all citizens.

JAMESTOWN EXPOSITION.

At the request of the North Carolina Commission to the Jamestown Exposition, the State Geologist was authorized by the Geological Board to take charge of the North Carolina mineral exhibit and to arrange for same. This work was undertaken early in January, 1907, and various mineral producers in the State were called upon for exhibits of their mineral products. In arranging for the mineral display, particular attention was given to those minerals which offer attractive investments for capital. Special emphasis was made of building stones and clay products and, through the co-operation of the North Carolina Granite Corporation, the Balfour Quarry Company, the Rowan Granite Company and the Consolidated Granite Company, it was possible to outline the space of the North Carolina exhibit with a balustrade of cut granite with two arches at the entrance, as is illustrated in the frontispiece of this report, which also gives a general idea of the installation of the exhibit. The building stones were further represented by columns and spheres of polished granite that surmounted the corners of the balustrade. The clay products were well represented by samples of crude kaolin and of pottery manufactured from it; and of terra cotta, tiling and sewer pipes, and bricks manufactured from other forms of clay.

The excellent collection of gems furnished by the American Gem and Pearl Co., of New York, the State Museum and by Joseph Hyde Pratt, represented fully the gems and gem minerals occurring in the State.

The mica, talc and monazite industries, were also comprehensively represented by crude, intermediate and finished products, arranged so as to illustrate the various steps of the manufacture of the materials into the finished products. These were furnished by the Sylva Mica Company, the North Carolina Talc and Mining Company, the American Lava Company, the Talcum Puff Company, the Glendon Mining and Manufacturing Company, the Croatan Company, the Carolinas Monazite Company, the Welsbach Light Company, the German-American Monazite Company, the Nernst Lamp Company, and the Highland Forest Company.

Other mineral resources exhibited were gold, copper and iron ores, corundum, chromite and tin minerals, coal, graphite and mineral waters.

The State Geologist was assisted in the installation and care of these exhibits during the period of the Exposition by Miss H. M. Berry, Messrs. R. T. Allen, Elden Bayley, Duncan MacRae and Joseph E. Pogue, Jr., and to them the State Geologist is indebted for their efficient work and their courtesy in explaining to visitors the character of the exhibits and seeing that the mineral samples and pamphlets for distribution were advantageously distributed.

It is the belief of the State Geologist that the mineral exhibit at the Jamestown Exposition, notwithstanding the comparatively small attendance, did attract the attention of capitalists to the mineral resources of the State and also brought many buyers to the producers of the mineral products. The actual benefit that the State derives from such an exhibit cannot be estimated in dollars and cents and very often results of the exhibit are realized years after the Exposition.

PUBLICATIONS.

During 1907 and 1908 the following publications have been issued by the North Carolina Geological and Economic Survey, which embody the results of the investigations briefly outlined above and to which references have been made:

VOLUMES.

II. The Fishes of North Carolina, by Hugh M. Smith, 453 pages, 21 pl., 188 figs.

BULLETINS.

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 60 pp., 15 pl.

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 74 pp., 17 pl., 11 figs.

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 74 pp., 10 pl., 16 figs.

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 38 pp., 6 pl., 2 figs.

ECONOMIC PAPERS.

14. Mining Industry in North Carolina during 1906, by Joseph Hyde Pratt. 144 pp., 20 pl., 5 figs.

15. Mining Industry in North Carolina during 1907, by Joseph Hyde Pratt.

16. Report of Convention Called by Governor R. B. Glenn to Investigate the Fishing Industries of North Carolina, compiled by Joseph Hyde Pratt, 1908. 47 pp., 1 map.

17. Report of Drainage Convention Called by the Geological and Economic Survey, compiled by Joseph Hyde Pratt, 1908.

Good Roads Circulars and Press Bulletins.

During the past two years 20 Good Roads Circulars and Press Bulletins have been issued and distributed throughout the State. These have taken up all sorts of questions pertinent to the subjects of good roads, forestry, waterpowers, drainage, fisheries, mining, etc. The object of these Press Bulletins is to bring constantly before the people of the State what work the Survey is doing so that, if they are interested in any particular line of work, they will know when it is being taken up and can obtain at an early date the information desired regarding it.

The following reports are now ready for the press and should be ready for distribution early in 1909.

BULLETINS.

18. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe.

20. The Waterpowers of North Carolina, by M. R. Hall, E. W. Myers and Joseph Hyde Pratt.

21. The Resources of the Coastal Plain Region of North Carolina, by L. W. Stephenson, E. W. Berry, B. L. Miller and Joseph Hyde Pratt in collaboration with W. B. Clark.

The following reports are in preparation:

VOLUMES.

III. Mineral Resources of North Carolina, by Joseph Hyde Pratt.

IV. Birds of North Carolina, by T. Gilbert Pearson and C. H. Brimley.

V. Mica and the Pegmatites of North Carolina, by Joseph Hyde Pratt and D. B. Sterrett.

VI. The Cretaceous and Tertiary Formations of North Carolina, by E. W. Berry and B. L. Miller.

BULLETINS.

Gold Hill Copper Deposits, by F. B. Laney.

A List of Elevations in North Carolina, by Joseph Hyde Pratt.

A Bibliography of North Carolina Geography, Geology, Mineralogy, Petrography and Paleontology, by Joseph Hyde Pratt, F. B. Laney and L. C. Glenn.

ECONOMIC PAPERS.

Mining Industry in North Carolina during 1908, by Joseph Hyde Pratt.

OFFICE WORK.

The office work of the Survey has been carried on by the State Geologist assisted by Mr. F. B. Laney, Assistant Geologist; Miss H. M. Berry, Secretary and Stenographer, with Mr. R. T. Allen, S. V. Bowen and Miss Nellie Barbee as temporary assistants. The correspondence of the Survey office requires a considerable part of the time of the State Geologist and his secretary and about 6,000 letters have been written at this office, besides circular letters, during the past two years. These letters relate to the value of mineral properties, methods for developing and mining of same, markets for mineral products, information regarding waterpowers, artesian wells and mineral waters, forests, available tracts of forest lands, different varieties of timber, etc.; the construction of public roads and localities for obtaining material for road construction; value of the oyster and fish industries and laws relating to same, etc. The Survey Office has tried to provide itself with all information possible relating to the natural resources of the State so that it will be in a position to answer any and all inquiries received relating in any way to our natural resources. For this reason, letters received at other Departments of State relating to natural resources are usually referred to this office for reply.

There is a constant demand for the various publications of the Survey, which are being sent into all parts of North Carolina, and requests are being received from all over the United States for them. The information that they contain has been the means of calling attention to various investment propositions in the State with the result that considerable capital has been brought into the State for developing them.

Each publication means considerable work for the State Geologist and the office force in editing the report and reading the proof of same as it is passing through the press.

In order to keep in touch with all publications relating to the geography and geology of North Carolina, a bibliography is being prepared relating to the geography, geology, mineralogy, petrology and paleontology of North Carolina. The State Geologist is being assisted in this work by F. B. Laney, Miss H. M. Berry and Miss Katherine Wood.

The following statement will show the receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1908, grouped according to the subjects investigated during this time. These are arranged separately for each of the two years. The receipts cover moneys received from the State Treasurer, representing the annual appropriation, and the sums received from counties and others for co-operative work of various kinds as indicated.

DECEMBER 1, 1906, TO NOVEMBER 30, 1907.

RECEIPTS.

Balance on hand		$578.72
Annual appropriation		10,000.00

DISBURSEMENTS.

General geology and copper investigations	$2,308.87	
General mineral investigations	843.42	
Coastal plain investigations	629.97	
Black sands and sand dune investigations and assay work	505.53	
Marl and peat investigations	201.40	
Swamp land and drainage investigations	100.00	
Good roads investigations	400.00	
Waterpower investigations	622.81	
Oyster and fish investigations	949.39	
Forestry investigations	305.20	
Topographic and traverse mapping	744.73	
Jamestown Exposition	300.00	
Geological Board expenses	284.35	
Clerical and editorial work	1,822.00	
Office expenses	561.05	
	$10,578.72	$10,578.72

DECEMBER 1, 1907, TO NOVEMBER 30, 1908.

RECEIPTS.

Annual appropriation		$10,000.00
Assay work		31.25
Granville Co. for traverse mapping		750.00
Beaufort Co. for traverse mapping		250.00
Board of Education for forest work		700.00

DISBURSEMENTS.

General geology and copper investigations	$1,834.58	
General mineral investigations	989.96	
Coastal plain investigations	594.24	
Swamp land and drainage investigations	610.97	
Good roads investigations	562.00	
Waterpower investigations	577.80	
Forestry investigations	1,631.01	
Topographic and traverse mapping	2,305.17	
Bibliography	93.00	
Geological Board expenses	212.27	
Clerical and editorial work	1,766.15	
Office expenses	550.06	
Balance on hand	4.04	
	$11,731.25	$11,731.25

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Postage 10 cents.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Postage 10 cents.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Postage 6 cents.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. A List of Elevations in North Carolina, by Joseph Hyde Pratt. *In preparation.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglass B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe. *In preparation.*

ECONOMIC PAPERS.

1. The Maple-Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt. 1901. 8°, 36 pp., and map. *Postage 2 cents.*

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Postage 2 cents.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Postage 2 cents.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Postage 4 cents.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt. *In press.*

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina. Compiled by Joseph Hyde Pratt, 1908. 8°, 45 pp., 1 pl. *Postage 4 cents.*

17. Report of Drainage Convention. Compiled by Joseph Hyde Pratt, 1908. 8°, —— pp. *Postage* ——.

VOLUMES.

Vol. 1. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. Miscellaneous Mineral Resources in North Carolina, by Joseph Hyde Pratt. *In preparation.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS, OR QUANTITATIVE DETERMINATIONS, WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1909-1910

RALEIGH
EDWARDS & BROUGHTON PRINTING CO., STATE PRINTERS
1911

NORTH CAROLINA GEOLOGICAL
AND ECONOMIC SURVEY

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1911

GEOLOGICAL BOARD

GOVERNOR W. W. KITCHIN, *ex officio Chairman* ..... Raleigh.
FRANK R. HEWITT ..... Asheville.
HUGH MACRAE ..... Wilmington.
C. S. VANN ..... Edenton.
R. D. CALDWELL ..... Lumberton.

JOSEPH HYDE PRATT, State Geologist ..... Chapel Hill

LETTER OF TRANSMITTAL

Chapel Hill, N. C., January 1, 1911.

To His Excellency, Governor W. W. Kitchin.

Sir:—I herewith submit for your consideration my Biennial Report to the Legislature of 1911 on the operations of the North Carolina Geological and Economic Survey for the fiscal years 1909 and 1910. Many of my recommendations have been made in the form of suggested legislation relating to public roads, the creation of a Highway Department and prevention of forest fires. I wish to call your particular attention to these special recommendations and also to the need of an increase in the appropriation for the general work of the Geological and Economic Survey of at least $5,000 annually.

All the work of the State Survey has been augmented by the hearty co-operation of the various Federal Departments, and thus the State Survey has been able to accomplish a great deal more than it could otherwise possibly have done.

Yours respectfully,

Joseph Hyde Pratt,
State Geologist.

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BIENNIAL REPORT

OF THE

STATE GEOLOGIST

On the Operation of the North Carolina Geological and Economic Survey for the Two Years Ending November 30, 1910

By JOSEPH HYDE PRATT, State Geologist

INTRODUCTION

In the act creating the North Carolina Geological and Economic Survey, it is stated, "that the Geological Board shall cause to be prepared and submitted to each Legislature a report showing the progress and expenditures of the Survey." In complying with the above it is not possible in the biennial report to give more than a brief outline of the work that has been accomplished by the members of the Survey during the two years which the report covers; and it is necessary to refer to the publications of the Survey which give detailed reports of the investigations that have been carried on, and to these the members of the General Assembly are respectfully referred. A list of all the publications of the Survey is given at the end of this report.

The objects of the North Carolina Geological and Economic Survey are much more varied than the name would imply, and their work embraces practically all investigations relating to the industrial advancement of the State except those relating directly to agriculture. As stated in the act, chapter 542 of the Public Laws of North Carolina of 1905, section 4, creating the Survey, the State Survey shall have for its objects:

(1) An examination of the mineral, forest, fishery and other material resources of the State.

(2) An examination of the geological formations of the State with reference to their economic products.

(3) An examination of the road-building materials and the best methods of utilizing the same.

(4) An examination and classification of the soils, the forests and other physical features of the State with special reference to their bearing upon the occupation of the people.

(5) An examination of the streams and water-powers of the State with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.

(6) The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.

(7) The preparation of such reports, illustrations and maps as may be deemed necessary in placing the results of these investigations before the public.

(8) And the State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and co-operation from the several United States Government Bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this act.

(9) An examination of the water supplies of the State with special reference to the sinking of deep or artesian wells.

As is seen from the above, the lines of work that are being undertaken by the Survey cover many fields, and their variation requires the employment of a number of men who are specialists in their particular line of work. For the past two years the personnel of the North Carolina Geological and Economic Survey has consisted of the following, who have been employed for either the whole or a part of the time:

Joseph Hyde Pratt, State Geologist.
F. B. Laney, Geologist.
J. E. Pogue, Jr., Assistant Geologist.
Douglas B. Sterrett, Assistant Geologist.
J. S. Holmes, Forester.
W. W. Ashe, Forester.
W. L. Spoon, Highway Engineer.
W. S. Fallis, Highway Engineer.
Miss Katherine Hill Wood, Bibliographer.
Miss H. M. Berry, Secretary.

W. B. Clark, L. W. Stephenson, E. W. Berry, B. L. Miller, Miss Julia A. Gardner. Harvey Bassler,	Geologists investigating Coastal Plain Resources.
R. L. Harrison, M. W. Gray, R. F. Irwin, E. P. Davis, R. D. Cummins, J. I. Gayetty, H. P. Rogers,	Topographers.
R. P. Coble, N. C. Hughes, Jr., R. T. Brown, C. C. Brown, Jr., J. M. Costner, Peyton McG. Smith. J. F. Speight, M. C. Lasitter, T. F. Hickerson, A. L. Feild, Jr., Elden Bayley,	Assistants in Road Engineering.
A. S. Wheeler, Chemist. Hampden Hill, Chemist.	
Susan Wooten, Mrs. E. S. McGehee, Della Richardson, Margaret Berry, Sophia Hart,	Stenographers.
Andrew Neville, Ernest Hutchins, W. A. Philips,	Office Assistants.

Besides the above there were eleven river observers, who made daily reports of the height of the river at their respective stations. These men were employed during 1909.

MINERALOGICAL AND GEOLOGICAL INVESTIGATIONS

MINERALOGICAL INVESTIGATIONS.

The principal work that has been done during the past two years relating to the minerals of North Carolina has been the collection of statistics regarding the production of each mineral that has been

mined or quarried in the State during each year. The statistics for the year of 1908 were published in Press Bulletin No. 33 of the publications of the Survey. The collection of the statistics for 1909 has been delayed on account of this year being the census year, and the work has been done in co-operation with the U. S. Geological Survey and the Bureau of the Census.

For the year 1910 the collection of the mineral statistics of the State, with the exception of gold, silver and copper, will be made by the State Survey in co-operation with the U. S. Geological Survey, and a very satisfactory arrangement has been made with the U. S. Geological Survey for this co-operative work. The following is the form of agreement between the two Surveys:

AGREEMENT FOR CO-OPERATION IN STATISTICAL WORK BETWEEN THE UNITED STATES GEOLOGICAL SURVEY AND THE GEOLOGICAL AND ECONOMIC SURVEY OF NORTH CAROLINA.

In order to avoid duplication of requests for statistical information covering mine and quarry operations, and also in order that the State Geologist may be kept in touch with the mineral producers of the State, the following agreement between the State Geologist and the Director of the United States Geological Survey is made for the collection of the statistics of mineral production (with the exception of gold, silver, copper, lead and zinc) in 1910.

As soon as possible after the first of December a numbered list of the mineral producers in the State of North Carolina (duplicate of the list used by the Federal Survey) will be sent to the State Geologist, who will check with the data in his office and notify the Federal Survey of any additions or corrections. These corrections will be made on the list of the Federal Survey, properly numbered, and the State Geologist advised of the number.

The blanks for the collection of the statistics will be printed at the expense of the United States Geological Survey and stamped with the statement that the work is done in co-operation with the State Survey. The inquiries will be mailed from the United States Geological Survey, but will contain a franked envelope for the return of the reply to the State Geologist.

If the State Geologist finds any errors or omissions to correct, he will retain the original report and return a copy to the producer for the necessary correction, which correction, when received by the State

Geologist, will be transferred to the original report. The latter will then be tabulated by him and forwarded immediately to the Federal Survey. The supply of blanks for securing these corrections will be furnished by the Federal Survey. If any additional corrections should be found necessary by the Division of Mineral Resources of the United States Geological Survey, they will be obtained by correspondence with the producers, and the State Geologist will be advised of any changes resulting therefrom.

The second and third requests for information will be prepared in the office of the Federal Survey in the same manner as the first request. The fourth request will be sent by registered mail after all attempts to secure returns by ordinary mail have been exhausted. The Director of the State Geological Survey will undertake to secure the reports of delinquents by personal visits of himself or his assistants.

Before any publication of results is made the totals for each subject will be submitted by the State Geologist to the Federal Survey for checking, and publication may be made by the State Survey as soon as the final figures are agreed upon. It is understood that in any preliminary or press notices thus issued, by either the Federal or the State Survey, credit for the co-operative plan will be given.

H. C. Rizer,
Acting Director United States Geological Survey.

Joseph Hyde Pratt,
State Geologist of North Carolina.

In collecting the statistics relating to the mineral production of the State there is a great deal of general information obtained, not only regarding the minerals that are being mined, but also in regard to accessory minerals occurring with those that are being mined for commercial purposes. This information will be well used in connection with the general volume on the minerals of North Carolina.

Mineral specimens are constantly being sent to the Survey office for identification and analysis. While the majority of these do not represent anything of commercial value, if occasionally one is found which does, and if there is any prospect of its occurring in commercial quantity, the Survey takes the necessary steps to bring the owner of this property in communication with those desiring such mineral. On the other hand, by notifying the individuals as to the nonvalue

of their specimens the Survey is able to prevent their spending considerable money for other assays or chemical analyses which would be of no value to them whatever. The Survey makes no charge for the mineralogical determination of a mineral or rock, but if a chemical analysis or assay is desired the work is turned over to one of the chemists of the State University, whose charges for this work are very reasonable.

During the past two years about two hundred and fifty samples of minerals have been examined and reported upon by the Survey.

Gold and Copper.—The mineralogical and geological investigations of the gold deposits of the Gold Hill and Cid Mining Regions of Rowan and Davidson counties have been completed, and these reports have been published in Bulletins 21 and 22. Both of these reports take up a thorough discussion of the occurrence of the gold and other minerals in the districts examined. There are a number of copper deposits also in both of these districts, and the reports cover these as fully as they do the gold. The field work for these reports was done by Dr. F. B. Laney in the Gold Hill District and Dr. J. E. Pogue, Jr., in the Cid District, all of the work being done under the supervision of the State Geologist.

Mica.—During the past two years work has been continued to some extent on the investigations relating to the mica and pegmatites of Western North Carolina. This work has been done by the State Geologist and Mr. Douglas B. Sterrett, of the U. S. Geological Survey. A considerable portion of this report is now in manuscript, and it is hoped it may be ready for the press during 1911.

GEOLOGICAL INVESTIGATIONS.

In connection with nearly all of the mineralogical investigations that have been made, small areas in various sections of the State have been mapped geologically, and all this work is being used in the preparation of the geological map of North Carolina. While only a limited amount of work can be accomplished each year along this line, yet, in a few years, it is hoped that a geological map of the State will be completed.

Coastal Plain Geology.—A geological map of the Coastal Plain Region of the State has been prepared in connection with the report on the Coastal Plain Region of North Carolina. This map is the result of the work that was done by the various geologists who have

worked in the Coastal Plain Region of North Carolina under the direct supervision of Dr. W. B. Clark, of the U. S. Geological Survey. Those who assisted in this work are: Messrs. L. W. Stephenson, E. W. Berry, B. L. Miller, Harvey Bassler and Miss Julia A. Gardner.

The report on the Coastal Plain Region has been in the hands of the public printer since the latter part of 1909, but for some reason it has been delayed, and it may be some months yet before it is ready for distribution. In connection with this report there is being published a report on the underground water resources of the Coastal Plain Region, which takes up in considerable detail the question of an artesian water supply for Eastern North Carolina.

Piedmont Geology.—The geological map of the Gold Hill Mining District has been completed and published and forms a part of Bulletin 21 on the Gold Hill Mining District. The geology on this map was by Dr. F. B. Laney. The geological map of the Cid Mining District has also been completed and published, and is a part of Bulletin 22 on the Cid Mining District. The geology on this map was by Dr. J. E. Pogue, Jr.

A geological and mineralogical report on the Virgilina Copper District is being prepared by the North Carolina Geological and Economic Survey in co-operation with the Virginia Geological Survey, and it will be published as a joint report by the two Surveys. The field work has been done largely by Dr. F. B. Laney, under the supervision of the State Geologists of North Carolina and Virginia. A geological map is being prepared of the district, and will be published as part of the report.

TOPOGRAPHIC AND TRAVERSE MAPPING OF THE STATE

The State Geological and Economic Survey has been co-operating with the U. S. Geological Survey for many years in the preparation of topographic and traverse maps of various parts of the State, and during the past two years this work has continued and a number of county traverse maps have been completed. Before any topographic mapping can be done it is necessary that a base or traverse map be prepared. It is these base or traverse maps which show all roads, railroads, streams, principal country houses, schoolhouses, churches, bridges and ferries, county and township lines that the counties especially desire. Arrangements have been made with the U. S. Geological Survey for making these traverse maps for certain counties be-

fore completing the topographic map. The following is a copy of the agreement under which this co-operative work is done:

Agreement for Co-operative Topographic Work.

AGREEMENT BETWEEN THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY AND THE STATE GEOLOGIST OF NORTH CAROLINA FOR THE CONTINUATION OF THE CO-OPERATIVE TOPOGRAPHIC SURVEY OF THE STATE OF NORTH CAROLINA, AS PROVIDED FOR IN AN ACT PASSED BY THE GENERAL ASSEMBLY, 1905 SESSION.

1. The preparation of the map shall be under the supervision of the Director of the United States Geological Survey, who shall determine the methods of survey and map construction.

2. The order in which, in point of priority, different parts of the State shall be surveyed shall be agreed upon in detail by the State Geologist of North Carolina and the Director of the United States Geological Survey, or their respective representatives.

3. The survey shall be executed in a manner sufficiently elaborate to prepare a map upon a scale of one or two inches to one mile, exhibiting the hydrography, hypsography and public culture, and all town and county boundary lines, township and section lines, as marked upon the ground at the time of its completion, in form similar to sheets already completed in this State. The preliminary field maps shall be on such scale as the Director of the United States Geological Survey shall select to secure accuracy in the construction of the final map.

4. The hypsography shall be shown by contour lines with a vertical interval to be hereafter selected by the two agreeing parties.

5. The heights of important points shall be determined and furnished to the State Geologist of North Carolina.

6. The outlines of wooded areas shall be represented upon proofs of the engraved map to be furnished to the State Geologist of North Carolina.

7. For convenience the United States Geological Survey shall, during the progress of the field work, pay the salaries of the permanent employees engaged thereon; while the traveling, subsistence and field expenses shall be paid for the same time by the State. During the office season the salaries shall be divided between the two agreeing parties in such a way as to equalize all expenses, provided that the total cost of the State of North Carolina for field and office work shall

not be more than two thousand five hundred dollars ($2,500), and provided that the United States Geological Survey shall expend an equal amount upon the work before June 30, 1910, the Federal allotment to bear an approximate charge of 12½ per cent for the necessary expenses in connection with the proper execution of the field and office work. All accounts shall be approved by a representative of the United States Geological Survey before payment.

8. During the progress of the work free access to the field sheets and records of the topographers and draftsmen shall be afforded the State Geologist of North Carolina, or his representative, for examination and criticism; and should the said State Geologist deem that the work is not being executed in a satisfactory manner, then he may, on formal notice, terminate this agreement.

9. The resulting maps shall fully recognize the co-operation of the State of North Carolina.

10. When the work is completed the State Geologist of North Carolina shall be furnished by the United States Geological Survey with photographic copies of the manuscript sheets; and when the engraving is completed, and at all times thereafter when desired, he shall be furnished by the said Survey with transfers from copper plates of the maps for use in printing editions of said maps.

Memorandum giving areas proposed for survey under this agreement by the Topographic Branch of the United States Geological Survey in co-operation with the State Geologist of North Carolina, for the period beginning June 18, 1909, and ending June 30, 1910:

A traverse survey of Franklin County, and other areas to be hereafter selected, as far as the funds will permit.

GEO. OTIS SMITH,
Director U. S. Geological Survey.

Washington, D. C., June 18, 1909.

JOSEPH HYDE PRATT,
State Geologist of North Carolina.

Chapel Hill, N. C., June 25, 1909.

During the past two years the field work has been completed on the traverse maps of Beaufort, Cleveland, Franklin, Granville and Pitt counties, and the adjustment of the field sheets is also completed and photographs of the maps have been sent to the County Commissioners of each county for approval. The Beaufort County map has been

engraved and three hundred copies sent to the County Commissioners for use in the county, one copy to be put into every schoolhouse in the county. The Franklin County map is now in the hands of the engravers, and should be ready for distribution at a very early date. There is printed on the county map a small black and white map of the State with the county that has been mapped shown in heavy black, so that any one looking at the map can, at a glance, see the exact relation of the county mapped to the other counties in the State. The counties have co-operated in the preparation of these maps, paying a certain proportion of the actual cost of the field work. The following is the form of agreement that the counties have made with the North Carolina Geological and Economic Survey:

Agreement With Counties.

AGREEMENT BETWEEN THE STATE GEOLOGIST OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY AND THE BOARD OF COUNTY COMMISSIONERS OF ..... COUNTY FOR THE PREPARATION OF A TRAVERSE MAP OF ..... COUNTY.

(1) The preparation of the map shall be under the supervision of the State Geologist, who shall determine the methods of survey and map construction.

(2) The map shall be a traverse map of the county, showing the roads, streams, principal country houses, schoolhouses, churches, bridges and ferries, county lines and township lines, and, if desired, school district lines.

(3) When the work is completed the Chairman of the Board of County Commissioners shall be furnished by the Geological and Economic Survey with a photographic copy of the map for use in making corrections, and, when the engraving is completed, the county shall be furnished with ..... hundred copies of the map.

(4) The Chairman of the Board of County Commissioners shall pay to the State Geologist on the first day of ....., 19....., ... dollars, and on the first day of each month for ..... months ..... dollars, making a total of ..... dollars.

The demand for these traverse maps is constantly increasing, as they are of great value to the county superintendents of public instruction and to those who have charge of road work in the different counties.

The State Geological Survey has also co-operated with the U. S. Geological Survey in the preparation of a base map of the State of North Carolina on the scale of 1:500,000. This basis map will be made from all the available data that can be obtained regarding North Carolina, and it will be the most accurate map of the State that has ever been published. This map will not, of course, show the detail that is given on the traverse maps of the different counties.

There is also a large demand for the topographic maps which are published as quadrangles, but the funds available for this work are very limited. It would undoubtedly be a very wise investment if the State would appropriate a certain amount each year for the special work of making at least traverse maps of the State, and the State Geologist would recommend that a special appropriation be made for this work.

SUGGESTION REGARDING AN ACT AUTHORIZING THE STATE GEOLOGIST TO CO-OPERATE WITH THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY IN MAKING TRAVERSE AND TOPOGRAPHIC MAPS OF PORTIONS OF THE STATE OF NORTH CAROLINA.

The General Assembly of North Carolina do enact:

Section 1. That in order to obtain as soon as possible a topographic and a traverse map of this State, the State Geologist is hereby authorized to confer with the Director of the United States Geological Survey and to accept the co-operation of the United States with this State in the execution of a traverse and a topographic survey and map of the State which is hereby authorized to be made; and that the said State Geologist shall have the power to arrange with said Director of the United States Geological Survey, or his authorized representative, concerning the details of the said work. The method of its execution and the order and point of time in which these surveys and maps of the different parts of the State shall be completed.

Sec. 2. The sum of ten thousand dollars annually for six years, or so much thereof as may be necessary for carrying out the purposes of this act, is hereby appropriated out of any moneys in the treasury of the State not otherwise appropriated, to be drawn upon as directed by the Geological Board.

Sec. 3. This act shall be in force and effect after its ratification.

During the past two years the following topographic maps have been completed and are or will be very shortly ready for distribution:

Charlotte, Gaffney, Kings Mountain and Lincolnton, which cover portions of Lincoln, Cleveland, Gaston, Rutherford, Mecklenburg and Union counties. The Lincolnton quadrangle was published on the scale of 1:125,000, and the other three on the scale of 1:62,500.

The following is a complete list of the topographic maps that have been published which cover portions of the State of North Carolina. The names given in capitals indicate that both the topographic sheet and the geologic folio have been published; of the others only the topographic sheet has been published. There is given in the second column the names of the counties, portions of which are covered by the topographic sheets. The list begins with the maps of the western part of the State. Some of these maps cover portions of other States, and this is indicated by the abbreviation of the State after the name of the topographic sheet.

LIST OF TOPOGRAPHIC MAPS IN NORTH CAROLINA.

Title of Map.	Portion of Counties Covered by Map.
Murphy, N. C.-Tenn.	Cherokee and Graham.
NANTAHALA, N. C.-Tenn.	Cherokee, Clay, Graham, Macon and Swain.
KNOXVILLE, N. C.-Tenn.	Swain.
MT. GUYOT, N. C.-Tenn.	Swain, Haywood and Jackson.
COWEE, N. C.-S. C.	Macon, Jackson, Swain and Haywood.
Ellijay, N. C.-Ga.-Tenn.	Cherokee.
Dahlonega, N. C.-Ga.	Cherokee, Clay and Macon.
Walhalla, N. C.-S. C.-Ga.	Macon
PISGAH, N. C.-S. C.	Transylvania, Jackson, Haywood, Henderson and Buncombe.
ASHEVILLE, N. C.-Tenn.	Buncombe, Haywood, Madison and Yancey.
GREENVILLE, N. C.-Tenn.	Madison.
ROAN MT., N. C.-Tenn.	Mitchell and Yancey.
MT. MITCHELL	Mitchell, Yancey, Madison, Buncombe and McDowell.
Saluda, N. C.-S. C.	McDowell, Buncombe, Henderson, Polk and Rutherford.
MORGANTON	Burke, McDowell, Rutherford, Cleveland, Caldwell and Mitchell.
CRANBERRY, N. C.-Tenn.	Watauga, Mitchell, Caldwell, Ashe and Wilkes.
Abingdon, N. C.-Va.-Tenn.	Ashe.
Wytheville, N. C.-Va.	Ashe and Alleghany.
Wilkesboro	Wilkes, Ashe, Alleghany, Watauga, Caldwell, Alexander and Iredell.
Hickory	Catawba, Alexander, Iredell, Caldwell, Burke, Lincoln and Wilkes.
Lincolnton	Lincoln, Cleveland, Gaston and Mecklenburg.
*King's Mt., N. C.-S. C.	Cleveland and Rutherford.
*Gaffney, N. C.-S. C.	Gaston and Cleveland
*Charlotte, N. C.-S. C.	Mecklenburg.
Statesville	Iredell, Catawba, Rowan, Davie, Mecklenburg and Cabarrus.
Yadkinville	Yadkin, Surry, Alleghany, Wilkes, Iredell and Davie.
Hillsville, N. C.-Va.	Surry and Alleghany.
*Spring Hope	Nash, Wilson and Franklin.
*Kenly	Wilson, Johnston, Nash and Wayne.
*Wilson	Wilson, Wayne and Greene.

LIST OF TOPOGRAPHIC MAPS IN NORTH CAROLINA.—Continued.

Title of Map.	Portion of Counties Covered by Map.
*Rocky Mount	Nash, Edgecombe and Wilson.
*Tarboro	Edgecombe and Wilson.
*Falkland	Pitt, Edgecombe, Wilson and Greene.
*Parmele	Edgecombe, Martin and Pitt.
*Winterville	Pitt and Greene.
*Ayden	Pitt, Greene, Lenoir and Craven.
*Trent River	Craven, Jones and Lenoir.
*New Bern	Craven and Jones.
*Vanceboro	Craven, Pitt and Beaufort.
*Chocowinity	Pitt, Beaufort and Martin.
*Williamston	Martin and Bertie.
*Great Coharrie	Sampson.
*Beckford	Hertford, Gates, Chowan, Perquimans and Bertie.
*Four Oaks	Sampson, Johnston and Wayne.
*Edenton	Chowan, Perquimans and Bertie.
*Winton	Chowan, Hertford and Gates.
*Hertford	Perquimans and Pasquotank.
Norfolk, N. C.–Va.	Pasquotank, Camden, Currituck and Gates.

*The maps marked by an asterisk are on the scale of 1:62,500, and the others on the scale of 1:125,000

In the following table the names of the counties of which topographic maps have been made are given in the first column, and in the second column the names of the topographic maps that cover the whole or a part of the county. The names of the county given in capitals indicate that the whole county has been topographically mapped.

TOPOGRAPHIC MAPS BY COUNTIES.

Names of Counties.	Topographic Sheets Covering Part of County.
ALEXANDER	Hickory and Wilkesboro.
ALLEGHANY	Wilkesboro, Wytheville, Hillsville and Yadkinville.
ASHE	Cranberry, Wilkesboro, Abingdon and Wytheville.
Beaufort	Chocowinity and Vanceboro.
Bertie	Williamston, Beckford, Edenton and Winton.
BUNCOMBE	Asheville, Mt. Mitchell, Pisgah and Saluda.
BURKE	Morganton and Catawba.
Cabarrus	Statesville.
CALDWELL	Cranberry, Morganton, Wilkesboro and Hickory.
Camden	Norfolk.
CATAWBA	Hickory, Morganton and Statesville.
CHEROKEE	Murphy, Nantahala, Ellijay and Dahlonega.
Chowan	Edenton and Beckford.
CLAY	Nantahala and Dahlonega.
Cleveland	Morganton, Lincolnton, Gaffney and King's Mt.
Craven	Vanceboro, Ayden, Trent River and New Bern.
Currituck	Norfolk.
Davie	Statesville and Yadkinville.
Edgecombe	Tarboro, Parmele, Falkland and Rocky Mt.
Franklin	Spring Hope.

TOPOGRAPHIC MAPS BY COUNTIES.—Continued.

Names of Counties.	Topographic Sheets Covering Part of County.
Gaston	Lincolnton and Gaffney.
Gates	Beckford and Winton.
GRAHAM	Nantahala and Murphy.
Greene	Falkland, Wilson and Ayden.
HAYWOOD	Asheville, Pisgah, Cowee and Mt. Guyot.
HENDERSON	Pisgah and Saluda.
Hertford	Winton and Beckford.
IREDELL	Statesville, Catawba, Wilkesboro and Yadkinville.
Jackson	Cowee, Pisgah and Mt. Guyot.
Johnston	Four Oaks, Kenly and Spring Hope.
Jones	Trent River and New Bern.
Lenoir	Ayden and Trent River.
Lincoln	Lincolnton, Hickory, Statesville and Morganton.
MACON	Cowee, Nantahala, Dahlonega and Walhalla.
MADISON	Asheville, Greenville and Mt. Mitchell.
Martin	Williamston, Parmele and Chocowinity.
McDOWELL	Mt. Mitchell, Morganton and Saluda.
Mecklenburg	Charlotte.
MITCHELL	Mt. Mitchell, Roan Mt., Cranberry and Morganton.
Nash	Spring Hope, Rocky Mt., and Kenly.
Pasquotank	Norfolk and Hertford.
Perquimans	Hertford, Edenton and Beckford.
PITT	Winterville, Chocowinity, Falkland, Parmele, Ayden and Vanceboro.
Polk	Saluda.
Rowan	Statesville.
Rutherford	Saluda, Morganton and King's Mt.
Sampson	Great Coharrie and Four Oaks.
SURRY	Yadkinville and Hillsville.
SWAIN	Cowee, Nantahala, Knoxville and Mt. Guyot.
Transylvania	Pisgah and Cowee.
Union	Charlotte.
Wayne	Four Oaks, Kenly and Wilson.
WILKES	Wilkesboro, Yadkinville, Cranberry and Hickory.
WILSON	Wilson, Falkland, Taboro, Rocky Mt., Spring Hope and Kenly.
Yadkin	Yadkinville.
YANCEY	Mt. Mitchell, Asheville and Roan Mt.

These topographic maps are not for free distribution, but can be obtained from the Director of the U. S. Geological Survey for five cents each, and in ordering them money order should be forwarded to the Director of the U. S. Geological Survey, and the maps should be ordered by name of the sheet.

GOOD ROADS

It is undoubtedly true that the greatest and most important problem that is confronting the State of North Carolina at the present time is that relating to the construction of good roads. The educational and industrial advancement of the State is vitally dependent upon good roads, and it is absolutely necessary for this State to be traversed by a system of well-constructed highways before it can

reach its highest development, either educationally or industrially. Transportation facilities are an essential factor in the growth of any State, but often "transportation facilities" are considered to apply only to railroads and waterways, while in reality the term is just as applicable to highways, for upon the latter depends the actual vitality of the State. The railways and waterways are the main lines or large veins and arteries for transportation, while the highways may be compared to the small capillaries penetrating every portion of the system, and thus it is the highways that are the real life-givers, inasmuch as they carry produce to and from every part of the State.

The State is realizing more and more the value of good roads, and is making tremendous strides toward creating a demand for them, and should now do more toward providing means for their construction. There is still, however, the need of a more concerted action on the part of the people before the State can reap to the fullest extent the benefits that a system of good roads will bring to her.

The biennial report of the State Geologist relating to good roads assumes greater importance this year than ever before, for the fact that the General Assembly of 1909 passed an act whose object was to promote and stimulate the construction and improvement of the roads in North Carolina, and they made a special appropriation for this purpose. As stated in the act:

"The object and purpose of this appropriation shall be to enable the North Carolina Geological Board to advise with the township and county authorities in the building and improvement of the public roads, by sending to the township or county a competent road engineer, who will assist them in locating their improved roads, advise them as to the best road to build and how to build it, and also give advice relating to the best kind of bridge to be built in connection with the improvement of any road. The Geological Board, through the State Geologist, may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best kinds of road material, and shall disseminate such knowledge by lectures to be given in the different counties and by preparing, publishing and distributing bulletins and reports on the subject of road improvement, and shall also gather and tabulate information and statistics on road building in North Carolina and disseminate the same throughout the State."

Although the appropriation made for carrying out the purpose of the act was small, yet a great deal has been accomplished, both from an engineering and educational standpoint, and there has been created throughout the whole State an increased desire and demand for good roads.

Soon after the passage of the act referred to above the Survey was fortunate in securing the services of Mr. W. L. Spoon as Highway Engineer. He had been one of the experts connected with the office of public roads of the U. S. Department of Agriculture.

Two distinct phases of work were undertaken:

(1) Educational, that of instructing the counties as to the value of good roads and how to obtain them, this being done by means of lectures and the construction, where possible, of a sample road; the other

(2) Engineering assistance, this consisting of sending into the county or township a competent road engineer who would take up with the county or township all questions relating to the location, construction and maintenance of all kinds of roads.

We have had the hearty co-operation of the Office of Public Roads of the U. S. Department of Agriculture, who have sent a number of engineers into the State to assist in the construction of sample roads and to give lectures on various topics pertinent to them, and the State Geologist takes pleasure here in acknowledging the indebtedness of the North Carolina Geological and Economic Survey to this Federal department for their hearty co-operation and for the encouragement that they have given us in our good roads work. We have also been assisted by individuals who have contributed liberally to the good roads work.

It was realized at the start that the funds available for this work would not begin to take care of the requests that would come in for assistance and advice regarding this subject, and the plan was adopted that the assistance to the counties would be taken up as far as possible in the order of the application of the county or township for such assistance. In order to facilitate the work and get in touch with the township and county road authorities the following circular and application blanks were prepared, which were sent to the county and road commissioners of each county:

STATE OF NORTH CAROLINA,
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY,
HIGHWAY DIVISION.
CHAPEL HILL, N. C.

By an act of the General Assembly of 1909 authority is given the North Carolina Geological and Economic Survey to give assistance to county and township road commissioners.

Acting under this authority, the Survey stands ready to aid the local road authorities in the order of their applications. As it would be of little value to survey roads upon which no improvement is contemplated in the near future, the following plan has been adopted in order to insure beneficial results:

When a county or township intends making any considerable improvement to a road or portion of a road, the Highway Division is ready to give such information as may be desired by the board of commissioners, both concerning the approximate cost and the best method of construction. In this way estimates of the cost of properly grading, draining and surfacing a particular piece of road can be had, which will be of value to the county.

To make clear the method of procedure, a blank application form is enclosed, which is to be filled in as indicated. The form is a request for a preliminary examination. In some instances it may be possible for the Highway Division to make detailed surveys, plans, profiles and specifications; and, through the Office of Public Roads at Washington, D. C., have available material tested. Further, if the work is carried on under plans and specifications furnished by the Highway Division, a general supervision of construction might be undertaken by the Division, should it be so desired.

The State Geologist and Highway Engineer stand ready to assist communities by general lectures and addresses on road subjects whenever possible and wherever sufficient interest is manifested to call a good roads meeting of the citizens of the community. In order to obtain this service, application should be made well in advance of the date of meeting. For this purpose a formal application is herewith enclosed.

The money available for this work is quite limited, and there may be a greater demand for this work than can be met. Every effort will be made, however, to comply with all reasonable requests, either from county or township boards desiring to improve the public roads.

Applications and letters relating to road work to be addressed to

JOSEPH HYDE PRATT,
State Geologist.

STATE OF NORTH CAROLINA,
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY,
HIGHWAY DIVISION.

Request is hereby made for an address or lecture on the subject of GOOD ROADS before a meeting of the citizens of.....County, to be held at ....., on ....., 19.....
Hour of meeting,.....
The object of the meeting is to.....
.....
.....
.....

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.....
.....

Names of parties requesting the address or lecture:

.....
.....
.....
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.....
.....

Date....., 19....

STATE OF NORTH CAROLINA,
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY,
HIGHWAY DIVISION.

REQUEST FOR PRELIMINARY EXAMINATION OF.....
ROAD IN.....COUNTY.

The County (or Township) Commissioners of.....
County (or Township) contemplate improving a portion of the road known as
.....
beginning at a point..... .....
and extending.....miles toward.....

Before beginning this work the Board of County Commissioners consider it desirable to have an approximate estimate of the cost of improving the section of road above mentioned, and for that purpose request that a preliminary examination be made by the Highway Division of the North Carolina Geological and Economic Survey.

Contemplate starting improvement....., 19....
(Signed).....
Clerk to Board of County (or Township) Commissioners.
Date.....

Applications both for engineering assistance and lecturers to address good roads meetings began to be received almost at once, and they have continued to come in throughout the two years; in fact it has been impossible to attend the good roads meetings that we have been invited to address, or to give the engineering assistance that has been requested.

During the past two years Mr. W. L. Spoon has made good roads addresses at the following places: Asheboro, Bakersville, Bat Cave, Brevard, Bryson City, Burnsville, Carthage, Columbus, Fair View, Franklin, Franklinton, Halifax, Hendersonville, Lenoir, Lexington, Marion, Marshall, Mocksville, Morganton, Morven, Oxford, Pitts-

boro, Raleigh, Rutherfordton, Sanford, Scotland Neck, Smithfield, Southport, Spruce Pine, Stantonsburg, Waynesville, Webster, White Cross and Wilkesboro.

The State Geologist has made good roads addresses at Asheboro, Asheville, Boone, Brevard, Burnsville, Carthage, Charlotte, Durham, Franklinton, Gastonia, Greenville, Halifax, Hendersonville, Hickory, High Point, Laurinburg, Lumberton, Marshall, Monroe, New Bern, Newton, Oxford, Pinehurst, Pittsboro, Randleman, Rocky Mount, Rutherfordton, Sanford, Spruce Pine, Stantonsburg, Troy, White Cross, Williamston, Winston-Salem, Wrightsville and Yadkinville.

Mr. Spoon has given engineering assistance to the following counties in connection with their county road work: Alamance, Brunswick, Buncombe, Cherokee, Cleveland, Columbus, Craven, Forsyth, Granville, Guilford, Henderson, Jackson, Lee, Lincoln, Madison, Rutherford, Stanly, Wilkes, Yadkin; engineering assistance to the following townships in regard to good roads within the township: Asheville Township, Buncombe County; Bingham Township, Orange County; Coble Township, Alamance County; Fairview Township, Buncombe County; Franklinton Township, Franklin County; Mebane Township, Alamance County; Morven Township, Anson County; New Bern Township, Craven County; Shelby Township, Cleveland County; Smithfield Township, Johnston County; Smithville Township, Brunswick County; Lockwoods Folly Township, Brunswick County; Valleytown Township, Cherokee County; Warrenton Township, Warren County, and Weldon Township, Halifax County; and engineering advice and assistance to the following towns: Andrews, Edgemont, Fair Bluff, Gibson, Goldsboro, Kinston, Kittrell, Lincolnton, Raleigh, Smithfield, Wadesboro, Whiteville, Wilkesboro and Winston-Salem.

Mr. W. S. Fallis, Highway Engineer to the Survey, has given engineering assistance at Bat Cave, Henderson County; Cleveland County; Durham County; Franklinton, Franklin County; Hickory, Catawba County; New Bern, Craven County; Rutherfordton, Rutherford County, and Valleytown Township, Cherokee County.

Assistance in bridge work has been given to Alamance, Cleveland, Craven, Durham, Franklin, Orange and Rutherford counties.

Engineering work has been done on special highways as the Charlotte-Asheville Highway, the Crest of the Blue Ridge Highway,

Raleigh-Greensboro Highway, and the Pinehurst-High Point Highway. In some of this work a complete survey has been made of the road so that a plan and profile could be prepared of the location.

There has undoubtedly been considerable interest aroused in good roads work from the lectures and addresses that have been given, and especially from the engineering assistance and advice. One result of the good roads agitation of 1909 was the calling of a convention at Asheville, October 5-7, which was known as the Southern Appalachian Good Roads Convention. This convention was planned and carried through by the North Carolina Geological and Economic Survey, and the State Geologist was chairman of the convention. A permanent organization was formed, known as the Southern Appalachian Good Roads Association. The State Geologist was elected president and the Highway Engineer, Mr. W. L. Spoon, secretary. This association is working in the closest harmony with the Geological Survey and has already accomplished a good deal along the line of interstate good roads construction. It published a good roads bulletin regularly once a month for eight months, the State Geologist being editor of same, when arrangements were made with *Southern Good Roads* to become the official organ of the association, and now its publications are printed in this magazine. The second meeting of the Southern Appalachian Good Roads Association was held at Knoxville, Tenn., October 5-6. This convention was as fully successful as the first one, and showed that a great deal of progress had been made in regard to the interstate roads. Prospects now are very encouraging for the early construction of a through road from Salisbury and Charlotte to Knoxville, Tenn., via Asheville; and from Greenville and Spartanburg, S. C., to Asheville, via Hendersonville. Another road that is being strongly advocated by the association is the Crest of the Blue Ridge Highway.

The section of the Southern Appalachian Mountains through which the Crest of the Blue Ridge Highway will pass contains the loftiest peaks east of the Rocky Mountains, with mountain slopes covered with a more varied fauna and flora than is found in any other section of this country. The grandeur of the scenery along this highway, comprising, as it will, extensive views into the Piedmont region, nearer views of deep valleys, and mountain tops and ridges, with here and there a most attractive and beautiful waterfall and streams of clear crystal water, and penetrating the dense evergreen forests,

whose deep shadows will almost cast a feeling of awe over the traveler as he passes through them, will make a ride over this highway one never to be forgotten.

The whole scheme for the construction of this highway has been carefully thought out, and a considerable portion of the route has been surveyed and a profile and plan has been prepared. A preliminary survey has been made of the balance of the route, so that the location of the road is pretty well known.

Briefly, the outline of the Crest of the Blue Ridge Highway is as follows:

Starting from some point on the Norfolk and Western Railway, as Marion, Virginia, the road would be constructed so as to pass close to White Top Mountain, which is a celebrated mountain in southwest Virginia, adjacent to the Norfolk and Western Railway. From near White Top the route would be through Ashe County, N. C., via Beaver Creek and Elk Cross Roads to Boone, Watauga County, N. C. From Boone to Blowing Rock the road is well graded, and with a small amount per mile spent for surfacing with sand-clay or gravel this part of the road will be in very good condition. From Blowing Rock to Linville, a distance of twenty miles, the road is also well graded. This road from Boone to Linville will practically need no relocation. From Linville to Linville Falls, via Pineola and Grassland, the present road can be used to a certain extent, but a considerable portion of it will have to be relocated on account of the grade. From Linville Falls to Altapass, a station on the Clinchfield Railway, the road will be an entirely new one. The survey has been carefully made and the road will open up some beautiful country. Altapass is the highest point on the Clinchfield Railway, and is already being developed as a resort. From Altapass the road is via Gillespie's Gap to Switzerland, a new resort that has been started within the last two years, Gooch Gap, Buck Creek Gap, Toe River Gap, Stepps Gap, which will be the highest point of the highway, where it reaches an altitude of approximately 5,500 feet. From Stepps Gap the road is via Balsam Gap, Bull Gap, to Asheville. From Buck Creek Gap to Bull Gap the highway is twining around through the most rugged portion of the Southern Appalachian Mountains, namely, the Black and Great Craggy Mountains. At Stepps Gap the road is only a short distance from the top of Mount Mitchell, and a side road can readily be built to the summit. The road has

branched off from the top of the Blue Ridge near Toe River Gap, in order to open up this important mountain section of North Carolina. Another road, however, is to follow the Crest of the Blue Ridge to the east of the Pinnacle (Mountain) to Swannanoa Gap, Black Mountain, Hickory Nut Gap, to Bat Cave and to Hendersonville, where it will join another road coming from Asheville to Hendersonville. At this point there will be another division, one road still following near the summit of the Blue Ridge to Brevard, Toxaway, Sapphire, Fairview, Highlands, Rabun Gap, Tallulah Falls, Clarksville and on to Atlanta. The other route will be from Hendersonville via Zirconia, Green River, N. C., Greenville, S. C., where it will join the National Highway from New York to Atlanta. At Asheville there is also being planned a continuation of the road via Weaverville, Mars Hill, Hot Springs, N. C., Newport and Dandridge, Tenn., to Knoxville.

The hardest part of this highway to construct will be that from Altapass through the Black and Craggy Mountains, as this is through a wild, very sparsely settled country, but when completed will be one of the best advertising features of the whole Southern Appalachian region, and will probably attract more attention to this region than anything else that has been contemplated. It will make Mount Mitchell accessible to practically every one who wishes to ascend the summit of this mountain, and Mount Mitchell will become as famous and as well known in connection with the Southern Appalachian Mountains as Pike's Peak is with Colorado and Mount Washington is with New Hampshire. With the highways leading to this road from Tennessee, Georgia, South Carolina, North Carolina and Virginia, there will undoubtedly be an enormous amount of travel, both by automobile and coach, over this road.

The natural sequence of the construction of this highway will be that there will be scattered all along the route beautiful and attractive inns, where the traveler will find the very best accommodations, which will tempt him to spend a week or more enjoying the views which will surround each and every such inn. Already such inns are being constructed, as the Eseola Inn, at Linville; the new inns at Altapass and Switzerland, and those in the Sapphire region.

The enterprise should prove a good financial investment, not only to the State, on account of the money which tourists will leave in the territory, but a financial success to the companies operating these por-

tions of the highway that it is necessary to make toll-roads, on account of the large number of automobiles and teams that would pass over the road.

Other projected highways which are being promoted by the North Carolina Geological and Economic Survey and various good roads associations are as follows:

Capital to Capital Route.—This route is interstate, extending from Richmond, Va., via Raleigh, N. C., Columbia, S. C., to Atlanta, Ga. The route across North Carolina will be either via Pleasant Hill, Roanoke Rapids, Littleton, Warrenton, Henderson, Kittrell, Franklinton, Wake Forest to Raleigh; or via Clarksville, Va., to Soudan, N. C., Oxford, Providence, Stem, Durham, to Raleigh; and then via Apex, Bonsal, Jonesboro, Cameron, Vass, Southern Pines, Pinehurst, Jackson Springs, Ellerbe, Rockingham, Hamlet, Osborne to Cheraw, S. C.

National Highway.—This highway, which extends from New York to Atlanta, follows in North Carolina the following route: From Ridgeway, Va., via Price, N. C., Stoneville, Madison, Ellisboro, Stokesdale, Kernersville, Winston-Salem, Lexington, Salisbury, China Grove, Landis, Concord, Newell, Charlotte, Belmont, McAdenville, Lowell, Gastonia, Bessemer City, Kings Mountain, Grover to Blacksburg, S. C.

Charlotte-Asheville-Knoxville Highway.—As far as Kings Mountain this highway follows the National Highway just referred to. At Kings Mountain the highway goes via Cherryville, Shelby, Blanton's Mill, Mooresboro, Forest City, Rutherfordton, Green Hill, Bat Cave, Chimney Rock, Fairview, Biltmore, Asheville, Weaverville, Mars Hill, Hot Springs, Paint Rock to Newport, Tenn.

Salisbury-Asheville Highway.—This highway follows the National Highway as far as Landis, then it turns west going via Mooresville, Brown's Store, Shuford Gold Mine, Newton, Conover, Hickory, Connelly Springs, Morganton, Marion, Old Fort, Swannanoa Gap, Black Mountain, Swannanoa to Asheville. At Hickory another highway will branch north via Granite Falls, Lenoir, Patterson to Blowing Rock, where it will connect with the Crest of the Blue Ridge Highway.

Charlotte-Wilmington Highway.—The exact route of this highway has not yet been definitely determined, but will probably be via Sardis, Matthews, Monroe, Wadesboro, Rockingham, Hamlet, Lau-

rinburg, Maxton, Lumberton, Boardman, Chadbourn, Whiteville, Lake Waccamaw and Wilmington. It is possible that the route from Lumberton to Wilmington may be via Clarkton, Bladen County.

Triangular Highway.—Considerable interest is being taken in a Triangular Highway extending from Pinehurst to Raleigh as the first leg of the triangle following the Capital to Capital Route; Raleigh to Winston-Salem as the second leg of the triangle, via West Raleigh, East Durham, Durham, Chapel Hill, White Cross, Saxapahaw, Graham, Burlington, Elon College, Gibsonville, Greensboro, Guilford Battleground, Oak Ridge, Kernersville to Winston-Salem; then Winston-Salem to Pinehurst as the third leg of the triangle, via High Point, Asheboro, Dewey, Steeds, Biscoe, Candor, Eagle's Springs and West End; there is also a first-class road connecting Greensboro with High Point, and thus making, if desired, the third leg of the triangle Greensboro to Pinehurst.

Through the efforts of the State Geologist the North Carolina Good Roads Association has been revitalized and is now making every effort to have formed in each county of the State a County Good Roads Association, these county associations to serve as units through which the State Association and the Geological Survey can reach all the people of the State. Thus far such associations have been formed in the following counties: Anson, Buncombe, Catawba, Columbus, Craven, Guilford, Halifax, Henderson, Macon, Mecklenburg, Montgomery, Moore, Orange, Randolph, Richmond, Robeson, Union and Wake.

The Survey has published from time to time good roads circulars giving special information relating to questions and problems pertinent to the construction and maintenance of good roads and revenue for carrying on the work.

In January, 1910, Mr. W. L. Spoon, Highway Engineer, gave a short course of lectures before a class of the farmers of the winter school of the A. and M. College. These lectures embraced the following subjects:

(1) Road location; first, from an economic standpoint relative to travel; second, from the wear and wash standpoint; third, from the standpoint of loads handled.

(2) Grades and loads; the load a given pull will transport over different grades; also relation of the road and grade.

(3) Drainage; the importance and absolute necessity of thorough

drainage, at the same time showing that excessive drainage or wash is expensive to road maintenance, the same as a deficiency of drainage.

(4) Surface materials: sand-clay, gravel, macadam, tar macadam, bitulithic.

(5) Repairs and maintenance of public roads.

(6) Concrete construction: culverts, bridges, etc.

The result of this good road work of the Geological Survey has been not only to create an interest and a demand for good roads, which is spreading over the entire State, but has also caused a great many of the people of the State to realize that the construction and maintenance of the public roads of North Carolina must be under the supervision of competent road engineers if the best results are to be obtained and if there is to be no waste of the road funds. It has been estimated that during the past two years there has been spent on the public roads of North Carolina in money and labor approximately $2,500,000, of which at least $750,000 was expended in such a way that it either did no good to the road or was an actual detriment to it; in fact, this amount could be considered as wasted, and the roads would have been just as well off if it had never been expended. The reason for this has been the lack of ability in road construction and maintenance of those who had the expenditure of this money. If the State would make sufficient appropriation to enable the Highway Division of the Geological Survey to give to the counties and townships the engineering assistance that they need in regard to their road work, and that the counties and townships would be compelled to follow the instructions of the Highway Engineer, there could be saved to the State each year a sum in excess of $300,000. To carry on this work will require an appropriation of at least $30,000, but when the saving to the State by means of this is considered it can readily be seen that it is one of the very best investments that the State could possible make.

A great many counties of the State are now employing their convicts on the public roads. but there are a great many of the counties that do not have a sufficient number of convicts to warrant their maintaining a chaingang, and in many instances these are leased to adjoining counties for work on the public roads. The Geological Survey is a strong advocate of convict labor in public road construction, not only for the county convict, but also for the State convict.

While it may not seem advisable or feasible at the present time to work all the State convicts on the public roads, yet we strongly advocate that all State convicts that are not needed for work on the State farms to be used in the construction of public roads, and that those counties which do not have a sufficient number of convicts of their own to make a chaingang that they be given the first opportunity to obtain from the State prison a sufficient number of convicts to make a chaingang; and that the balance of the convicts to be used on such intercounty or interstate roads as may be decided by the Highway Division of the Geological Survey or a Highway Commission, if such is established, to be the most important and of greatest advantage to the State.

As stated above the Highway Division of the North Carolina Geological and Economic Survey has been very greatly assisted in its highway work by the Office of Public Roads of the U. S. Department of Agriculture. During the past two years they have constructed object lesson roads of a half mile or more in length as follows: At Clarkton, a sand-clay road; Fayetteville, sand-clay road; Southport, sand-clay and shell road; Nashville, sand-clay road; Laurinburg, sand-clay road; New Bern, sand-clay road; Edenton, sand-clay road; Salisbury, sand-clay road.

Special inspection and advice was given at Burlington, Oxford, Weldon, Fayetteville, Nashville, Rich Square, Lexington, Salisbury, New Bern, Goldsboro, Southport, Manteo, Candor and Biscoe.

Lectures on good roads were delivered at the following places by engineers of the U. S. Office of Public Roads:

Apex; July 5, 1909; L. E. Boykin.
Carthage; July 19, 1909; Raymond E. Toms.
Star; July 21, 1909; Raymond E. Toms.
Elise; July 22, 1909; Raymond E. Toms.
Mt. Gilead; July 23, 1909; Raymond E. Toms.
Asheboro; July 24, 1909; Raymond E. Toms.
Denton; July 26, 1909; Raymond E. Toms.
Thomasville; July 27, 1909; Raymond E. Toms.
Hoffman; July 29, 1909; Raymond E. Toms.
Laurinburg, July 30, 1909; Raymond E. Toms.
Maxton; July 31, 1909; Raymond E. Toms.
Rich Square; July 21, 1909; Charles R. Thomas, Jr.
Scotland Neck; July 22, 1909; Charles R. Thomas, Jr.
Nashville; July 24, 1909; Charles R. Thomas, Jr.
Whitaker; July 26, 1909; Charles R. Thomas, Jr.
Sanford; July 26, 1909; L. E. Boykin.

Cameron; July 27, 1909; L. E. Boykin.
Southern Pines; July 28, 1909; L. E. Boykin.
Washington; July 29, 1909; L. E. Boykin.
Grimesland; July 30, 1909; L. E. Boykin.
Grimsley's Church; July 31, 1909; L. E. Boykin.
Asheville; October 6, 1909; M. O. Eldridge.
Hickory; October 14, 1909; L. E. Boykin.
New Bern; December 7, 1909; George D. Marshall.
West Raleigh (4 lectures); January 20-22, 1910; D. H. Winslow.
Southport; June 11, 1910; D. H. Winslow.
Manteo (2 lectures); July 8-13, 1910; E. W. James.
Greenville; August 1, 1910; L. E. Boykin.
Williamston; August 2, 1910; L. E. Boykin.
Washington; August 3, 1910; L. E. Boykin.
Plymouth; August 4, 1910; L. E. Boykin.
Columbia; August 5, 1910; L. E. Boykin.
Swan Quarter; August 8, 1910; L. E. Boykin.
Wrightsville Beach; June 9, 1910; J. E. Pennybacker, Jr.
Southport; June 11, 1910; J. E. Pennybacker, Jr.
Belhaven; August 8, 1910; L. E. Boykin.
Edenton; August 6, 1910; L. E. Boykin.
Hertford; August 9, 1910; L. E. Boykin.
Currituck; August 10, 1910; L. E. Boykin.
Elizabeth City; August 11, 1910; L. E. Boykin.
Gatesville; August 12, 1910; L. E. Boykin.
Winton; August 13, 1910; L. E. Boykin.

It is really necessary that the State should take a still more definite action regarding the highway work of the State, and the following legislation is suggested, and it is earnestly hoped that the General Assembly of 1911 will enact these or similar suggestions into laws which the Geological Survey believes will be for the best interests of the State at large.

Suggested Legislation for Creating a State Highway Department.

The General Assembly of North Carolina do enact:

Section 1. There is herewith created a State Highway Department, which shall consist of a State Highway Commission and a State Highway Engineer. The Highway Commission shall consist of the State Geologist, who shall be chairman of the commission, a professor of Civil Engineering in the University of North Carolina to be selected by the president of said University; a professor of Civil Engineering in the North Carolina College of Agriculture and Mechanical Arts, to be selected by the president of said college, and

two civilians, to be appointed by the Governor within thirty days after the passage of this act, who shall hold office for four years and until their successors are appointed, unless removed for cause. The members of the commission shall receive their actual traveling expenses while attending the meeting of the commission. All vacancies in the membership of said commission shall be filled in same manner as is prescribed for the original appointments.

Sec. 2. As soon as practicable after the passage of this act the said State Highway Commission shall appoint a competent Civil Engineer, who is experienced in highway construction and maintenance as State Highway Engineer. He shall hold office for a term of four years and until his successor is appointed, unless removed for cause by the said State Highway Commission. The State Highway Engineer shall execute and file with the Secretary of State a bond to the people of the State in the sum of $5,000, with securities to be approved by the State Highway Commission, conditioned for the faithful performance of his duties. The State Highway Engineer may appoint such assistant engineers, clerks and other assistants as may be necessary to the proper conduct of the work of said Commission by and with the advice and consent of the said Commission, whose compensation shall be determined by the Highway Commission.

Sec. 3. The object and purpose of this Commission shall be to instruct, assist and co-operate in the building and improving of the public roads under the direction of the State Highway Engineer of such counties and townships of the State of North Carolina as shall comply with the provisions of this act. The State Highway Commission may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best methods of road-making and the best kinds of road material, and prepare, publish and distribute bulletins and reports on the subject. The said State Highway Commission shall hold meetings at such times and for such purposes as they may deem essential to the proper carrying out of the provisions of this act. The State Highway Commission shall make biennial report to the Legislature of the work of the State Highway Department.

Sec. 4. The State Highway Engineer shall have charge of all the records of the State Highway Department; shall keep a record of all proceedings and orders pertaining to the business of his office and

of the department, and shall keep on file copies of all plans, specifications and estimates prepared by his office. He shall cause to be made and kept by the State Highway Department a general highway plan of the State, and shall collect information and compile statistics relative to the mileage, character and condition of the highways and bridges in the different counties of the State, and shall, within one year from the passage and approval of this act, prepare a map of such of the main highways in the State as, in his judgment, are of sufficient importance to be designated as a system of trunk or State roads to be improved and maintained at the cost of the State, and report same to the State Highway Commission for submission to the Legislature for adoption as a proposed system of trunk or State roads, which if adopted, or as adopted by the Legislature, shall be improved as soon thereafter as possible, under such provisions as the Legislature may enact therefor. He shall investigate and determine the methods of road construction best adapted to the various sections of the State, and shall establish standards for the construction and maintenance of highways in the various counties, giving due regard to the topography, natural conditions, character and availability of road-building material and the ability of the counties to meet their portion of the cost of building and maintaining roads under the provisions of this act. He may at all reasonable times be consulted by county or township officers having authority over highways and bridges, relative to any question involving such highways and bridges, and he may, in like manner, call on such county or township officials for any information or assistance as they may render in the performance of his duties, with reference to the highways and bridges within their county or township, and it shall be the duty of such county or township officials to supply such information when called upon for same by the said State Highway Engineer. He shall determine the character and have the general supervision of the construction and repair of all roads improved under the provision of this act. He shall report all the proceedings of his office to the State Highway Commission at such time and place as they may designate.

Sec. 5. In order to obtain the benefits of this act the County Commissioners in any county in this State may, at any time, by resolution, request the Highway Commission that any public road or section of road located within said county, being at least one mile in length, or, being less than one mile in length, if an extension or connection with

some permanently improved or paved street, or permanently improved highway of approved construction, be improved by the construction of a macadamized road, or a telford or other stone road, or a road constructed of gravel, brick or other suitable material, in such manner that the same, of whatever material constructed, shall, with reasonable repairs thereto, at all seasons of the year, be firm, smooth and convenient for travel; or whenever a road or section or improvement thereof is petitioned for by the owners of fifty-one per cent of the lineal feet along said road or section thereof, praying the Board of County Commissioners to cause such roads to be improved under this act, it shall be the duty of such board to make request to the Highway Commission, if, after viewing such road, said Board of Commissioners shall decide the improvement of such road to be just and to the best interest of the public, subject to the conditions as hereinafter provided. When more roads are applied for than can be constructed in one year, the Board of County Commissioners and Highway Engineer shall have power and authority to select from the roads petitioned for the ones first to be constructed, having first regard to the most important roads and the distribution of the benefits of this act to all parts of the county.

Sec. 6. The Highway Engineer shall, upon receipt of any such application, investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purposes of this act, taking into account the use, location and value of such highway or section thereof for the purpose of common traffic and traveling, and after such investigation shall certify his approval or disapproval of such application. If he shall disapprove such application he shall certify his reasons therefor to the Board of County Commissioners making the application.

Sec. 7. If the Highway Engineer shall approve of such application he shall cause the highway or section thereof, therein described, to be mapped both in outline and profile. He shall indicate how much of such highway or section thereof may be improved by deviation from or alteration of the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness, or whenever such deviation or alteration is of advantage by reason of lessened gradients; and shall cause plans and specifications of such highway or section thereof to be made for telford, macadam or gravel roadway, or other suitable construction, taking

into consideration the climate and soil and the material to be had in the vicinity thereof, and the extent and nature of the traffic likely to be upon the highway, specifying in his judgment the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight nor more than sixteen feet in width, unless for special reasons, to be stated by such Highway Engineer, it is required that it shall be of greater width. All highways improved under the provisions of this act shall conform to the standard of construction established by the State Highway Department.

Sec. 8. Upon the completion of such maps, plans and specifications of a proposed improvement the State Highway Engineer shall cause an estimate to be made of the cost of construction of the same, and transmit the same to the Board of County Commissioners from which such resolution proceeded, together with a certified copy of such maps, plans and specifications, and of his certificate of the approval of the highway or section thereof so designated as aforesaid.

Sec. 9. After the receipt thereof upon a majority vote of such Board of County Commissioners it may adopt a resolution that such highway or section thereof so approved shall be constructed under the provisions of this act, or of any existing act, and thereupon shall transmit a certified copy of such resolution to the State Highway Engineer.

Sec. 10. In case such proposed highway shall deviate from the existing highway the officials making application must provide for securing the requisite right of way by condemnation proceedings, or otherwise, prior to the actual commencement of the work of improvement, and shall secure release from damage to property by reason of change of grade.

Sec. 11. That upon the receipt of the application and certified copy of the resolution provided for in section 9, the State Highway Engineer shall advertise for bids for two successive weeks, in one newspaper of general circulation published in the county in which the road is to be built, according to said plans and specifications, which shall be on file at the County Commissioners' office, and shall award such contract to the lowest responsible bidder, subject, however, to the approval of the County Commissioners. No contract shall be awarded at a greater sum than the estimate provided in section 8: *Provided,* that when bids are received for such improvement

they shall be sealed bids and shall be protected with such other regulations as may be imposed by the County Commissioners necessary to secure fair bids. But if no bid otherwise acceptable be made within such estimate, such Highway Engineer may amend his estimate, certify the same to the Board of County Commissioners, and, upon the adoption by it of a resolution as provided in section 8, based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Said County Commissioners may reject any and all bids, and before entering into any contract for such construction shall require a bond with sufficient sureties, or by a surety company of recognized standing, conditioned that if the proposal shall be accepted the party thereto will perform the work upon the terms proposed and within the time prescribed, and in accordance with the plans and specifications, and as a bond of indemnity against any direct or indirect damage that shall be suffered or claimed during the construction of such road and until the same is accepted. The State of North Carolina shall in no case be liable for any damages suffered.

Sec. 12. Upon the completion of any highway, rebuilt or improved under the provisions of this act, the Highway Engineer shall immediately ascertain the total cost and expense of the same and apportionment of the total cost and expense between the State and the county, and the Highway Engineer shall certify the total expense of said improvement to the County Commissioners, signifying the amounts contracted to be borne by the State and the county.

Sec. 13. One-fourth of the cost and expense of the construction thereof shall be paid by the Treasurer of the State of North Carolina on the warrant of the State Auditor, issued upon requisition of the State Highway Engineer, approved by the Chairman of the North Carolina Highway Commission, out of any specific appropriations made to carry out the provisions of this act, and three-fourths of the cost and expense thereof shall be a county charge in the first instance, and shall be paid by the Treasurer of the county in which such highway or sections thereof is located, upon the order of the County Commissioners upon the requisition of the State Highway Engineer, out of any funds in the county treasury for the construction of improved highways under the provisions of this act: *Provided,* that not more than five thousand dollars shall be paid by the

State for highway construction work in any one county in a single year.

Sec. 14. No money shall be advanced by the State of North Carolina or by the County Commissioners in payment of the cost and expense of construction provided herein except as the work of actual construction progresses, to be paid upon estimates made by the engineer in charge of the work, and in no case shall the payment or payments of the State of North Carolina and the County Commissioners made thus prior to the completion of the work be in excess of eighty per centum of the value of the work performed, and in all cases twenty per centum must be held until the completion of the work, according to the plans and specifications; and every county or township availing itself of the provisions of this act shall, because of having accepted such State aid, contract and bind itself to maintain and keep said road in good and efficient repair, for the free use of the public.

Sec. 15. Every contract authorized to be made by the State Highway Commission under the provisions of this act shall be made in the name of the State of North Carolina, shall be signed by the Highway Engineer and attested by the Chairman of the Highway Commission, and must be approved by the Board of County Commissioners of the county in which the improvement is to be made: *Provided further,* that no contract for any highway improvement shall be let by the State Highway Commission, nor shall any work be authorized under the provisions of this act until the written agreement of the County Commissioners of the county in which the proposed improvement is to be made, agreeing to assume their respective share of the cost thereof, as hereinbefore provided, shall be on file in the office of the State Highway Department, and shall have been approved as to form and legality by the Attorney-General.

Sec. 16. The improvement of roads under provisions of this act shall be taken up and carried forward in the respective counties of the State as far as practicable in the order of the date of receipt of the application therefor from the supervisors of the respective counties, or as the State Highway Commission may determine; but no county shall be entitled to receive State aid as provided in this act unless and until it shall first be made to appear to the State Highway Engineer that the money with which to meet the proportion of said expenses to be borne by the county is either already in the hands of

the County Treasurer, or will be so in hand, and immediately available upon the completion and acceptance of said work improvement.

Sec. 17. No State highway shall be dug up or otherwise used for laying pipe lines, sewers, poles, wires or railways, or for other purposes, without the written permit of the State Highway Engineer, and then only in accordance with the regulations prescribed by said engineer; and all such work shall be under the supervision and to the satisfaction of said engineer, and all the cost of replacing the highway in as good condition as previous to its being disturbed shall be paid by the persons to whom, or in whose behalf, such permit was given, or by the person by whom the work was done. In case of immediate necessity therefor a city or town may dig up in such State highway without such permit from said engineer: *Provided,* that in such cases such highway shall be forthwith replaced in as good condition as before, at the expense of such city or town. And any one violating this section shall be guilty of a misdemeanor, and shall, upon conviction, be fined or imprisoned in the discretion of the court.

Sec. 18. The State Highway Engineer, with the approval of the State Highway Commission, may purchase for the State all rock crushers, steam rollers and other road machinery, tools and implements that may be needed for the purposes of this act, and such machinery shall be managed and used under the direction of said engineer, who shall employ competent men to operate and keep them in repair. Said engineer may purchase all necessary materials and supplies and incur other expenses as may be necessary in the operation, maintenance and transportation of all such road machinery, tools and implements. Upon the application of the Board of Commissioners of any county, said State Highway Engineer may furnish such road machinery, when convenient and practicable, for use in building or repairing any road or roads in such county, all expenses incurred thereby to be borne by said county.

Sec. 19. In all cases of highway construction under the provisions of this act the right of way, which shall be at least forty feet in width, therefor shall be acquired by the county either by donation by the owners of the land through which such highway shall pass or by agreement between such owners and the supervisor of such county, or through the exercise by the County Board of Commissioners of the power of eminent domain, in the same manner as pro-

vided for acquiring property for other public uses, and the entire cost of such right of way shall be paid by the county. Any person who may consider himself aggrieved by such determination may, upon petition filed in the Superior Court of the county in which said highway lies within six months after the completion of said highway or alteration thereof, have said damages determined by a jury in the same manner as damages which have been sustained by the taking of land for other public purposes. Any such damages as may be awarded shall be paid by the county, and the State shall not be in any way liable for such damages.

Sec. 20. The said State Highway Engineer shall have authority to employ any and all labor necessary to carry out the provisions of this act, and shall pay such labor the reasonable and customary price per day for the class of work performed. The said State Highway Engineer, in order to facilitate the carrying out of the provisions of this act, shall also have authority, with the concurrence and approval of the Board of Directors of the State's prison, to use for highway work all convict labor which may be available, without prejudice to work on the State farms or other public works of the State on which such convict labor is used, said convicts to be worked under the rules and regulations, and subject to the guardianship and supervision of the said Board of Directors of the State's prison.

Sec. 21. In order to provide funds for carrying out the provisions of this act the Auditor of the State is hereby authorized in addition to the levy for general State purposes, to levy an annual tax of one-fourth of one mill on every dollar of taxable property in the State, which shall be collected as other State taxes are collected and paid into the State treasury, and there held as a "State highway fund" for the exclusive uses and purposes of this act; also any moneys accruing from the licensing or registration of automobiles within the State, over and above the necessary expenses incident to such licensing or registration, including salaries of necessary officers and assistants for same, shall be paid into the State treasury and applied to the said "State highway fund" for the exclusive uses and purposes of this act. Any portion of said State fund unexpended at the expiration of any fiscal year shall remain in said fund and be available for apportionment and expenditure during succeeding fiscal years.

Sec. 22. The term "State Highway," as used in this act, shall be construed to include all highways constructed under the provisions

of this act and all such highways heretofore constructed to which the aid of the State has been extended.

Sec. 23. All acts or parts of acts in conflict with the provisions of this act are hereby repealed.

Sec. 24. This act shall be in force from and after ratification.

Suggested Legislation for Road Engineering Assistance to Counties.

The General Assembly of North Carolina do enact:

Section 1. In order to further the work of the Highway Division of the North Carolina Geological and Economic Survey in rendering road engineering assistance to counties in the construction and maintenance of their public roads, there is hereby appropriated, out of any moneys in the treasury not otherwise appropriated the sum of $40,000 annually for the purpose of carrying out the provisions of this act, the same to be drawn upon as directed by the Geological Board.

Sec. 2. Any county desiring engineering assistance from the North Carolina Geological and Economic Survey shall make application for such assistance on blanks specially prepared for this purpose, to be furnished by the State Geologist, and any county through its county or road commissioners accepting such engineering assistance shall agree to carry out the instructions of the Highway Engineer of the North Carolina Geological and Economic Survey, and shall further agree to construct and maintain the roads according to the instructions to be given by the said engineer. Engineering assistance shall also be furnished to the counties relating to the best kind of bridge to be built in connection with the improvement of any road, and any county or township that is contemplating the construction of a bridge to cost over $500 shall not let the contract for said bridge until the plans and specifications for said bridge have been approved by the North Carolina Geological and Economic Survey, and the final payment equal at least to 20 per cent of the contract price shall not be paid by the county or town officials until the construction of said bridge has been approved by the engineer of the North Carolina Geological and Economic Survey. The engineer of the North Carolina Geological and Economic Survey shall also furnish to the county or township commissioners having in charge the road work an estimate of what the proposed bridge should cost, and no bid shall be accepted by said commissioner in excess of the esti-

mate made by the said engineer. If no bid is received by said commissioners at or under the estimate made by the said engineer, the letting of the contract shall be re-advertised, and if no bids are then received at or under the estimate of the said engineer, the said commissioners can with the approval of said engineer accept a bid in excess of the estimate.

Sec. 3. This act shall be in force from and after its ratification.

Suggested Legislation for Working State Convicts on the Public Roads.

The General Assembly of North Carolina do enact:

Section 1. That all convicts sentenced to State's Prison who are not required in carrying on the work of the State's Prison and of the State farms shall be used in working the public roads as hereinafter provided.

Sec. 2. The Superintendent of the State's Prison shall allot the State convicts to work on the public roads as directed by the Chairman of the State Highway Commission, if such office shall be created by the General Assembly, or otherwise by the State Geologist. When counties shall apply for State convicts to assist in the construction and maintenance of their public roads, preference shall be given to those counties which do not have a sufficient number of convicts of their own to warrant their maintaining a chain-gang for public road work. When thus allotted to the counties for such work, the county receiving such convicts for road work shall pay the cost of guarding, feeding and clothing the convicts, and this shall be done in a manner satisfactory to the Superintendent of the State's Prison. Where it is considered advisable by the Highway Commission, if such Commission has been established by the General Assembly, or the Geological Board, the State convicts may be used in the construction of intercounty roads and the cost of guarding, feeding and clothing the convicts shall be done by the Superintendent of the State's Prison.

Sec. 3. This act shall in no way interfere with the present acts relating to the sentencing of prisoners to work on the roads, and which are now under the control of county authorities.

Sec. 4. This act shall be in force from and after its ratification.

Suggested Legislation for Providing Funds for the Construction of Public Highways.

The General Assembly of North Carolina do enact:

Section 1. That for the purpose of assisting the several counties composing the State of North Carolina in their construction of public roads, the State Treasurer is hereby authorized and directed to issue bonds of the State of North Carolina, payable forty years after date of issue of said bonds, which shall be the first day of July of each year beginning with the first day of July nineteen hundred and eleven, to an amount not to exceed five hundred thousand dollars annually, and all said bonds shall bear interest at a rate not exceeding four per cent per annum from the first day of July of the year they are issued until paid, which interest shall be payable semi-annually on the first days of January and July of each and every year so long as any portion of said bonds shall remain due and unpaid.

Sec. 2. That the proceeds received by the State Treasurer from the sale of the bonds authorized in this act shall be loaned to the several counties of the State of North Carolina, as hereinafter provided, to be used by said counties in the construction of macadam, sand-clay or other surfaced roads as approved by the Highway Engineer of the Highway Department, if such is established by the General Assembly, or by the Highway Engineer of the North Carolina Geological and Economic Survey.

Sec. 3. That the proceeds from sale of the bonds authorized in this act shall be allotted to the several counties composing the State of North Carolina in proportion to the amount of taxes that the said counties pay into the State Treasury, and any amounts allotted to counties that are not applied for by the counties for which allotted within six months after their allotment shall be re-allotted, and loaned amongst the other counties.

Sec. 4. The counties accepting the said loans from the State Treasurer shall pay to the State Treasurer each year five per cent of the amount loaned by said Treasurer to said county, which amounts shall be payable semi-annually on the first days of January and July of each and every year for a period of forty years from the date of loan. Of the said five per cent paid by the county to the State Treasurer, four per cent is to be used by the State Treasurer to pay the State's interest on the bonds issued to cover said loans, and one

per cent is to be retained by the State Treasurer as a sinking fund with which to redeem the bonds issued at the end of forty years, when said bonds mature.

Sec. 5. There shall be levied in each and every county accepting a loan or loans, as provided for in this act, a special annual tax for a period of forty years, to be known as the "Road Loan Tax," which shall be sufficient to pay, and shall be used in paying, the annual interest on the loan, said interest to be paid by the Treasurer of the county to the Treasurer of the State of North Carolina semi-annually on the first days of January and July of each year. As collateral for said loan made by the State of North Carolina to the county, the County Commissioners shall issue county bonds to the amount of said loan, and deposit same with the State Treasurer, to be returned to the county at the end of forty years.

Sec. 6. No county shall be allowed to borrow money under the provisions of this act to an amount exceeding five per cent of the assessed valuation of the property of the county.

Sec. 7. Any county accepting a loan under the provisions of this act from the State of North Carolina shall expend this money in the construction of macadam, sand-clay or other surfaced roads, which shall be located, constructed and maintained under the supervision of the Highway Engineer of the Highway Department, if such is established by the General Assembly, or the Highway Engineer of the North Carolina Geological and Economic Survey.

Sec. 8. That the bonds authorized and directed to be issued by section one of this act shall be coupon bonds and of the denomination of five hundred dollars ($500) and one thousand dollars ($1,000) each, as may be determined by said State Treasurer, and shall be signed by the Governor and the State Treasurer and sealed with the great seal of the State. The coupons thereon may be signed by the State Treasurer alone, or may have a facsimile of his signature printed, engraved, or lithographed thereon; and the said bonds shall in all other respects be in such form as the said State Treasurer may direct, and the coupons thereon shall, after maturity, be received in payment of all taxes, debts, dues, licenses, funds and demands due the State of North Carolina of any kind whatsoever, which shall be expressed on the face of said bonds. Before selling the bonds herein authorized to be issued, the Treasurer shall advertise the sale and invite sealed bids in such a manner as in his judgment may seem to

be most effectual to secure the best price. He is authorized to accept bids for the entire issue or any portion thereof, and where the advantages are equal he shall give the preference of purchase to the citizens of North Carolina; and he is authorized to sell bonds herein authorized in such a manner as in his judgment will produce the best price.

Sec. 9. The said bonds and coupons shall be exempt from all State, county or municipal taxation or assessment, direct or indirect, general or special, where imposed for purposes of general revenue or otherwise, and the interest thereon shall not be subject to taxation as for income, nor shall said bonds and coupons be subject to taxation when constituting a part of the surplus of any bank, trust company, or other corporation.

Sec. 10. It shall be lawful for all executors, administrators, guardians and fiduciaries generally to invest in said bonds.

Sec. 11. This act shall be in force from and after its ratification.

HYDROGRAPHY

STREAM MEASUREMENTS.

Up to June 1, 1909, thirty gaging stations were maintained in North Carolina by the United States Geological Survey and the North Carolina Geological and Economic Survey in co-operation with each other. Besides the daily gage readings of the height of the water in the streams at the point where these stations are located, there has been made at intervals discharge measurements which give the actual amount of water passing the station each minute. Data obtained at these stations is used in determining the value of the water-powers on the various streams and rivers. These stations have been maintained for about twelve years, and the information thus collected regarding the flow of streams has been compiled and published in a bulletin (No. 20) on the water-powers of the State. Since January 1, 1910, the State Geological Survey has not maintained any gaging stations.

Water Resources.—A report on the water resources of the Coastal Plain Region has been made and the manuscript sent to the public printer a year ago. In this report descriptions are given of each county in Eastern North Carolina regarding its water resources, and the possibility of obtaining artesian water. This is still in the hands of the public printer.

Swamp Lands and Drainage.

Since the passage of the North Carolina Drainage Act by the General Assembly of 1909 a great deal of interest has been aroused not only among the people of North Carolina but among others outside the State in the reclamation of our swamp lands. This act makes it possible to drain the swamp and overflowed lands of Eastern and Piedmont North Carolina. That the citizens of these portions of the State appreciate the value and effectiveness of the State Drainage Act is evidenced by the fact that there are now nineteen drainage districts formed or in the process of formation, most of which have been surveyed and mapped. The districts are as follows:

The Mattamuskeet Lake Drainage District No. 1, of Hyde County.
The Moyock Drainage District No. 1, of Currituck County.
Bear Creek Drainage District, of Chowan County.
Pungo Creek Drainage District No. 1, of Beaufort County.
Pungo Creek Drainage District No. 2, of Beaufort County.
Little Contentnea Creek Drainage District, Wilson County.
Lyon Swamp Drainage District, of Pender and Bladen counties.
Toisnot Creek Drainage District, Wilson County.
Chadbourn Drainage District, of Columbus County.
Belvidere Drainage District, of Hertford County.
The Creswell Drainage District, of Washington County.
Deep Creek Drainage District, Pitt County.
The Dover Drainage District, Craven County.
Back and Jacob Swamp Drainage District, Robeson County.
The White Oak Swamp Drainage District, Bladen County.
Deep Creek Drainage District, Edgecombe and Halifax counties.
Angola Bay Drainage District, Pender County.
Pantego Drainage District, Hyde County.
Juniper Bay Drainage District, Hyde County.

In the Piedmont section investigations have been made regarding several areas of overflowed lands with the result that the following drainage districts have been organized or are in the process of organization:

On Clark's Creek, of Lincoln and Catawba counties.
On Muddy Creek and Mill Creek, of Forsyth County.
On Third Creek, Iredell County.
Big Brown Creek Swamp, Anson County.
Horse Pen Creek, Guilford County.
Haw River, Rockingham County.

Three of the drainage projects referred to above have been practically completed; two in Eastern North Carolina—one the Toisnot

Swamp Drainage District of Wilson County, and the other Pungo River Drainage District No. 1, Beaufort County—and the third in Piedmont North Carolina, on the overflowed lands of Clark Creek of Catawba and Lincoln counties. The results obtained from the drainage of all three of these districts have been most satisfactory and have been a great impetus to future drainage work both in Eastern and Piedmont North Carolina.

The drainage work in North Carolina is under great indebtedness to the Office of Drainage Investigations of the United States Department of Agriculture, and the State Geologist takes pleasure at this time in expressing the indebtedness and appreciation of the North Carolina Geological and Economic Survey and of the North Carolina Drainage Association for the hearty co-operation that they have received from this department of the Federal Government, and to which the success of the drainage work in this State is largely due. This department has assisted in making the preliminary surveys of a large number of the drainage districts.

As the Drainage Act did not seem to be thoroughly understood by the people of Eeastern North Carolina, and as many of our larger farmers had an idea that they could drain their lands cheaper and perhaps better than by becoming a part of a drainage district, and as many of the small farmers who owned but a few acres had an idea that they would be unjustly taxed if they should enter a drainage district and would have to bear a large part of the cost of the drainage, it was decided to hold another Drainage Convention at New Bern. This convention was held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey on November 11 and 12, 1909. Delegates were present at this convention from twenty-two counties, and the results of the convention were extremely satisfactory and undoubtedly did a great deal toward clearing up misconceived ideas regarding the operation of the drainage law. There was a thorough discussion in regard to the practicability of draining low swamp lands and on the operation of the drainage law. The proceedings of the convention have been published by the Survey as Economic Paper No. 18.

A third Drainage Convention was called by the North Carolina Drainage Association and the North Carolina Geological and Eco-

nomic Survey, which was held November 22 and 23, 1910, at Wilmington, N. C. This convention was perhaps the most widely attended of the three conventions. Every delegate who attended was vitally interested in the subject of drainage, and there were twenty-three counties represented. The sense of the convention is expressed in the resolutions that were adopted, which were as follows:

"*Resolved*, That this Association request the Trustees of the State Agricultural and Mechanical College to make provision for a complete course of drainage engineering, and we commend to the young men of the State who are pursuing the study of agriculture that they include in their course the essential problems of drainage. The President and Secretary of this Association are hereby directed to present a copy of this resolution, in person, if possible, to an early meeting of the Trustees of the A. and M. College.

"*Resolved*, That this Association unreservedly commend the law authorizing the teaching of agriculture in the public schools, and especially in the rural districts, and we urge that some of the elementary principles connected with drainage be included in the agricultural course. To this end we request the State Superintendent of Public Instruction to communicate with the county superintendents, and, through them, with the teachers and district committees. The President and Secretary of this Association are directed to present this resolution to the State Superintendent of Public Instruction, and, through him, to the next session of the Legislature.

"*Resolved*, That the Legislature be requested to enact legislation which shall relieve drainage bonds from all taxation, State, county, or municipal, for a period of fifteen years, provided the Legislature has the constitutional power to enact such a law. We refer to all bonds which may be issued during the next fifteen years. We are advertent to the inhibition against exemption from taxation of private property, but we submit that these bonds are excluded from such prohibited class. Drainage is more than a semi-public function. The public health and the construction of highways are exclusively within the province of the State, and both are substantially, if not entirely, subserved and promoted by drainage. Whatever is lost in the way of public revenue will be more than met by the increased value of lands added to the taxable property. We are constrained to regard this legislation of paramount importance in the successful organization and establishment of drainage districts throughout the State. The President and Secretary of the Association are directed to present this resolution to the next session of the Legislature, through the appropriate committees of both houses, and the President is authorized to appoint any additional members of the Association to join in the presentation and the promotion of such a law.

"*Resolved*, That we urge the Legislature, at the next session, to enact a law authorizing the State Geological and Economic Survey to employ a competent drainage engineer, under the supervision of the State Geologist, who may be employed in visiting sections where drainage is contemplated, and confer with the land owners and make preliminary investigations, with a view to determining whether the said lands are susceptible of drainage, and within a limit of cost which would constitute a profitable investment, such investigation to be preliminary to the institution of a proceeding for the establishment of a drainage dis-

trict, and that the necessary appropriation be made to meet the expenditure involved. We also urge the Legislature to appropriate a sufficient fund out of which may be paid the compensation of the drainage engineer, as provided in section 2 of the General Drainage Law of 1909, the said sum so advanced to be subsequently refunded."

The President and Secretary of the Association are directed to present this resolution at the next session of the Legislature, through the appropriate committees of both houses:

"*Resolved*, That the State Department of Agriculture be earnestly requested to establish a demonstration farm at some point where the alluvial soil exists, with a view to demonstrating the productive capacity of the soil for the various crops."

The President and Secretary of the Association are directed to present this resolution and to continue to urge the same upon the attention of the Department of Agriculture:

"*Resolved*, That this Association, on behalf of the people of North Carolina, express deep gratitude to the United States Department of Agriculture, and particularly to the Bureau of Drainage Investigations of that Department, for the most helpful assistance and co-operation with the State of North Carolina, in the making of preliminary investigations and surveys, and for expert advice in the solution of many drainage problems. That the Secretary of the Association be directed to communicate a copy of this resolution to Hon. James Wilson, Secretary of Agriculture, and to Dr. C. G. Elliott, Chief of Drainage Investigations.

"*Resolved*, That the thanks of the Association be tendered to the Secretary of the Treasury and the Chief of the Revenue Cutter Service for the courtesy extended in placing the Revenue Cutter "Seminole" at the disposition of the local committee, and providing a most delightful trip down the Cape Fear River and to various points of interest.

"That we extend thanks to the Board of County Commissioners of New Hanover County for the use of the commodious and comfortable court room for the sessions of this Convention. That we also extend most grateful thanks to the Chamber of Commerce, the local committee and the citizens of Wilmington, for the many and delightful courtesies extended to the members of the Association, which have contributed in such large degree to a successful session and to the pleasure of the delegates. That we can not forget the obligations which we owe to the press of the city of Wilmington and also of the State, in reporting the proceedings of this Convention. Publicity and agitation are necessary in furthering this great public movement, in which the press must be a most valuable auxiliary."

The calls upon the State Geologist for information regarding drainage work and for inspection of proposed drainage districts are very numerous, and it is absolutely impossible for him to visit the districts as often as this should be done and to give the necessary information by means of addresses and personal intercourse with

people interested in the formation of drainage districts, or to make a preliminary examination of these districts in order to give advice as to whether the people should petition for a drainage district. It is earnestly desired and hoped that the General Assembly will increase the general appropriation of the Geological Survey so that it will be enabled to employ an engineer to assist in this work.

At a meeting of the State Board of Education early in 1910 a resolution was passed requesting the State Geologist to assist the State Board in connection with the Mattamuskeet Lake Drainage District No. 1. The State Geologist has, therefore, looked after the interests of the State Board of Education in this drainage district, and has approved all accounts before they have been paid. He has also supervised to some extent the conduct of the work and arranged a plan for obtaining agreements of boundary lines between adjacent landowners and the lands belonging to the State Board of Education. The reports on the various drainage districts that have been established thus far in North Carolina are being published in the form of an economic paper, which will be available within a short time.

FORESTRY

The protection and perpetuation of the forests of North Carolina has become one of the more important problems and studies of the North Carolina Geological and Economic Survey. It has been estimated that approximately eleven million acres of land in North Carolina are now supporting some kind of forest growth. Nearly one-half of this area is probably absolute forest land, that is the land is too rough to cultivate properly; is too easily washed by rain or floods; is too poor to yield adequate returns for the labor put upon it, or, for other reasons, the production of timber crops is the most profitable use to which it can be put, for a great many years to come. This large amount of forest land represents an investment of from twenty-five to fifty million dollars at the least. One-sixth of the entire wealth-producing capital of the State is invested in forest lands or in industries directly depending upon the products obtained from the forests. Thus it is seen that the problems relating to forestry are most vital to the industrial life of the State, and the State should put forth every effort to make these forests as nearly perpetual as she possibly can, and encourage and stimulate the owners of these lands to assist her in conserving them.

The Geological and Economic Survey has from its investigations realized most thoroughly the need of conserving and protecting the forest areas of the State, and has for the past two years employed constantly a forester to investigate and assist in carrying out measures that would tend toward awakening the people of North Carolina to a realization that some legislation must be enacted to prevent the total destruction of our forests, and thus one of the most valuable assets of the State.

The forestry work has been varied in character and consists of:

1. An investigation of the forest conditions of North Carolina.
2. A study of forest fires in North Carolina.
3. A statistical study of the wood-using industries of North Carolina.
4. The examination of timber areas in regard to practicing scientific forestry.
5. Examination of watersheds belonging to municipalities in regard to their protection from fire and contamination.
6. Investigations regarding the re-forestation of abandoned farm lands and cut-over lands.

For the first six months the work was conducted by Mr. W. W. Ashe as Forester, but he resigned in May, 1909, and Mr. J. S. Holmes, who for seven years had been connected with the United States Forest Service, was appointed Forester to succeed Mr. Ashe, and took up the work on June 1st.

Mr. Ashe continued the work of the examination of the larger portion of the swamp areas in Eastern North Carolina that belonged to the State Board of Education. These lands have been located, their timber value determined, and also their value as agricultural land. A report has been prepared for the State Board of Education on the swamp lands claimed by this Board. The lands claimed can be divided into two well-defined classes according to their condition and location.

Swamp Lands are those that are usually swamp or liable to inundation with *fresh* water and the bottoms of lakes. They are situated from a few feet to as much as a hundred feet above sea level and are susceptible of drainage and subsequent cultivation.

Marsh Lands, on the other hand, border tidewater and are never more than a foot or two above mean low tide level. As a consequence these marsh lands are covered with from one to two or three feet of *salt* or *brackish* water at high tide and are not susceptible to drainage except by a dike system, the cost of which would probably

be, in most cases if not in all, prohibitive at the present time. The bulk of the land owned by the Board of Education is of the first type, there being probably not over 50,000 acres of the second type of land, and this is scattered in small tracts along the coast. The largest tracts of this marsh land are in Hyde County, where there is one area of several thousand acres along the south shore, and in Carteret County an area which contains a good many thousand acres.

There was also prepared early in 1909 a manual for the State Board of Education to be used as a guide for Arbor and Forest Day Exercises.

TIMBER RESOURCES.

In order to obtain more accurate knowledge regarding the timber resources of the State it was decided to make a thorough investigation of the various conditions county by county, so that the Geological and Economic Survey would be in a position to answer the many questions that were being asked regarding our forestry resources, such as:

What are our forest resources, and how long are they likely to last at the present rate of timber consumption?

Can we insure a permanent supply for our manufacturers, as well as for domestic and other uses?

Is the timber land yielding to its owners and to the State as large returns on the enormous amount of money invested as is possible?

Can the actual yield be increased?

Arrangements were made with the United States Forest Service whereby an investigation of the forest conditions of the State could be made, and for the past two field seasons this work has been carried on by the two departments according to the following agreement:

AGREEMENT BETWEEN THE UNITED STATES DEPARTMENT OF AGRICULTURE (FOREST SERVICE) AND THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

This agreement, made and entered into this.....day of....., 19....., between the Secretary of the United States Department of Agriculture and the State Geologist of the North Carolina Geological and Economic Survey—WITNESSETH:

That for and in consideration of the mutual promises herein contained and of the mutual benefits to be enjoyed hereunder, it is agreed as follows:

1. That the North Carolina Geological and Economic Survey and the Secretary of the United States Department of Agriculture shall make a field study of the forest resources and forest conditions of the State of North Carolina and shall collect data which can be used in preparing a report or reports covering the following subjects:

(a) A map of the State or a portion of the State showing the distribution of the forests.

(b) The percentage of forest land in each county, together with its comparative value for agriculture, for the production of timber, and as a protection for streams.

(c) The percentage and location of the principal forest types, together with the approximate stand of timber per acre of the different species.

(d) The percentage and location of second-growth pole stand, and the age where possible.

(e) Data for ascertaining the yield of even-aged second-growth stands, both (1) fully stocked, and (2) thinned, of (a) sprout hardwoods; (b) seedling hardwoods; (c) and pine; and the most practicable methods of managing each in the different forest types.

(f) A study of the most practicable methods of managing the different forest types to produce as nearly as possible the special kinds and amount of timber required by the industries.

(g) A study of the various methods of lumbering to determine the changes, if any, which can be recommended to improve the condition of the forest and to prevent unnecessary waste.

(h) A study of the allied industries, such as farming, stock raising, and mining in their relation to the forests, in order that the relative importance of each may be determined.

(i) The damage, costs, frequency, and effects of forest fires, with the object of working out some practical system of fire protection.

(j) The practicability of planting in forest trees the abandoned fields or other waste land, with the object of preventing erosion and producing timber.

Said report shall be as complete as the available funds will permit, shall contain recommendations for private owners in the handling of their lands to maintain and improve the forests, and shall contain a recommendation for a State forest policy and a State forest law, if advisable.

2. That the study which is carried on under this agreement shall

be planned and conducted jointly by duly authorized representatives of the Forest Service and the North Carolina Geological and Economic Survey, and shall be subject to the approval of the proper authorities in each case.

3. That during the progress of the field work, a brief report shall be made in duplicate at the end of every month by the officer in charge and submitted to the Forester and the State Geologist.

4. That neither the Forest Service nor the North Carolina Geological and Economic Survey shall publish any of the results of this work until the report of such results is approved by both the Secretary of the United States Department of Agriculture and the State Geologist of the North Carolina Geological and Economic Survey. After such approval, the State shall have prior right to publish the results relating to general forest conditions in the State, and the Forest Service shall have prior right to publish results relating to the condition, value, and yield of second-growth stands, but in all such publications the fact shall be plainly stated that the results were obtained through co-operation with the North Carolina Geological and Economic Survey and the United States Department of Agriculture.

5. That the North Carolina Geological and Economic Survey and the Forest Service shall share equally the cost of carrying out this agreement on the following basis:

The North Carolina Geological and Economic Survey shall supply the service of its Forester for such length of time as will require the expenditure of at least $1,200 for his salary and field expenses while so employed and shall deposit with the Treasurer of the United States for this purpose not less than $1,200 nor more than $1,800 in quarterly installments of not less than $400 each, which shall be used for paying the salary and expenses of the representative of the Survey.

The Forest Service shall supply the services of some of its employees as assistants to the Forester of the North Carolina Geological and Economic Survey for a sufficient length of time to require an expenditure of an amount equal to that deposited by the North Carolina Geological and Economic Survey for salary and field expenses of such employees while acting as such assistants.

6. That no member of or delegate to Congress shall be admitted to

any share or part of this agreement or to any benefits to arise thereupon. (Rev. Stat., 3741.)

Executed in triplicate the day and year in this agreement first written. W. M. Hays, (L. S.)

Acting Secretary United States Department of Agriculture.

Joseph Hyde Pratt, (L. S.)

State Geologist North Carolina Geological and Economic Survey.

The first year under this co-operative agreement the sixteen counties west of the Blue Ridge were thoroughly investigated and a report prepared on the timber resources of these counties. This will be published as a bulletin of the Geological and Economic Survey. The next year (1910) twenty-four counties east of the Blue Ridge were examined and a report is now in preparation on the timber resources of these counties. This work of the Forestry Division of the Survey is perhaps as important and valuable as any that is being undertaken, inasmuch as it will give the State a comprehensive and detailed inventory of its timber resources.

FOREST FIRES.

By far the greatest enemy which the forests of the State have to contend with is fire. The destruction wrought by the annual and periodic fires which burn over many thousand acres of woodland each year involves an enormous loss to the people of the State through the diminished value of their property. No attempt has ever been made to collect statistics regarding the amount of damage to our forests from this source, but it was considered advisable by the Survey to obtain such data so that it could show more forcibly to the people of the State what they were losing each year from the effects of forest fires. Unfortunately forest fires usually have been taken as a matter of course by our people, and in many cases have scarcely been noticed. Our lumbermen, however, have begun to realize that with the possible exception of land supporting mature pine timber with little or no young growth, ground fires can do and are doing great injury to our timber lands. Our farmers and other landowners are beginning to realize that every time a ground cover of leaves is burned up the land becomes that much poorer. Owners of water-powers know that with the burning of the woods the rains run off faster, permitting a much smaller amount of water to soak into

the soil, so that floods and periods of low water are both more frequent. Cattlemen who have contended that by burning the range they get earlier grass for their stock are now beginning to realize that in doing this they are really killing the goose that lays the golden egg, for by burning they get less and less grass every year. The man who owns forest land and is holding it for increase of growth, both for domestic supply and for sale, has learned that he is losing at least half the yield he ought to get by allowing his woodland to be burned over. Unfortunately, however, it is necessary to instruct the people at large regarding the great loss to the State by forest fires before we can obtain legislation that will give the necessary protection. In order to obtain accurate information to disseminate throughout the State a study of the forest fires in North Carolina during the year of 1909 was undertaken by the State Geological and Economic Survey in co-operation with the Forest Service of the United States Department of Agriculture. The points considered in the investigation were as follows:

1. The total number of fires in the county during the year.
2. The area burned over, whether it contained merchantable timber, young timber not yet ready to cut, or land on which the best timber has already been cut.
3. The amount and value of the merchantable timber that has been destroyed.
4. The amount and value of forest produces destroyed in the shape of saw logs, lumber, ties, bark, cord wood, etc.
5. The value of improvements destroyed, such as fences, barns, houses, mills, etc.
6. Value of live stock destroyed.
7. Number of human lives sacrificed.
8. The total cost of fighting fires, both to the individual, lumber company, etc., and to the county or township.
9. The cause of fires.

The results of this study have been published in Economic Paper No. 19 on "Forest Fires in North Carolina During 1909." Although the Survey was not able to obtain as full information as was desired, yet the suggestions that have been collected are of considerable importance and show the need of some legislation to prevent as much as possible this enormous waste that is caused each year by forest fires, which amounted in 1909 to between one-half and three-quarters of a million dollars, and burned more than 400,000 acres of forest land.

Although there are a number of laws on the statute books of North Carolina relating to forest fires, yet the machinery necessary to carry

out these laws has never been passed, and it is absolutely necessary that other laws shall be passed if we are to preserve our forests from fire. The following legislation relating to the prevention of forest fires is suggested:

Suggested Legislation to Protect the Forests of North Carolina From Fire.

The General Assembly of North Carolina do enact:

Section 1. That section 3346 of the Revisal of 1905 be amended to read as follows: If any person shall set fire to any grass land, brush land or any woods except it be his own property, or, in that case without first giving notice in writing to all persons owning or in charge of lands adjoining to the woodland or other land intended to be fired, at least two days before the time of firing such lands, and also taking care to watch such fire while burning and taking effectual care to extinguish such fire before it shall reach any lands near to or adjoining the land so fired, he shall, for every such offense be guilty of a misdemeanor and be punishable by a fine of not less than twenty-five dollars nor more than one thousand dollars, one-half to go to the person who brings the suit and one-half to go to the State Treasurer, to be used for forest protection, or by imprisonment for a term of not less than three months nor more than five years, or by both such fine and imprisonment. This shall not prevent action for damages sustained by the owner of any property.

Sec. 2. That section 3347 of the Revisal of 1905 be amended to read as follows: "Any wagoner, hunter, camper or other person who shall leave a camp fire without fully extinguishing it, or who shall permit any accidental fire from any torch, gun, match, or other origin, to burn in any grass or woodland without fully extinguishing it, shall be guilty of a misdemeanor and upon conviction shall be punishable by a fine of not less than twenty-five dollars, one-half to go to the person who brings the suit and one-half to the State Treasurer, to be used for forest protection, as herewithin provided.

Sec. 3. In any township or part thereof for which forest wardens have been appointed under the provisions of this act, waste, fallows, stumps, logs, brush, dry grass or fallen timber shall not be burned between the first day of February and the first day of June of any year unless the written permission of the State Geologist or Forester

of the North Carolina Geological and Economic Survey or of the county, township or district forest warden of the county, township or district in which such fire is set has been first obtained. Such permission shall not be granted by any forest warden if, in his opinion, any forest or woodland will be endangered thereby, nor shall such permission, if granted, relieve or exonerate any person from any penalties under this act, in case by reason of such fire, any forest, brushland or woodland be burned: *Provided, however,* permits shall not be necessary for burning said materials when the fire is set in a public road, garden or powed field at a distance of not less than two hundred feet from any woodland, brushland or field containing dry grass or other inflammable material.

Sec. 4. All persons who shall burn any tar kiln, or pit of charcoal, or set fire to or burn any brush, grass or other material whereby any property may be endangered or destroyed, shall keep and maintain a careful and competent watchman in charge of said kiln, pit, brush or other material while burning.

Sec. 5. Every person or company operating a logging railroad locomotive or any other engine in or near any woodland in this State shall equip the same with an efficient spark arrester, and any person or company who operates one not so equipped shall be guilty of a misdemeanor and subject to a fine of not less than ten dollars or more than one hundred dollars for each such offense, one-half to go to the person who brings the suit and one-half to the State Treasurer, to be used for forest protection.

Sec. 6. All railroad companies operating any railroad through forest lands within this State shall equip their locomotives with efficient spark arrester, to be approved by the Corporation Commission, and shall keep their right-of-way cleared of all combustible materials and safely dispose of the same within said limits of said right-of-way. No railroad company shall permit its employees to leave a deposit of fire or live coals on its right-of-way other than between the rails, in the immediate vicinity of woodland or lands liable to be overrun by fires, and when engineers, conductors or trainmen discover that fences or other materials along the right-of-way, or woodland adjacent to the railroad, are burning or in danger from fire, they shall report the same promptly at the next telegraph station that they pass. In seasons of drought the railroad companies shall give particular instructions to their section foremen for the prevention and prompt

extinguishment of fires originating on its right-of-way, and they shall cause warning placards furnished by the State Geologist or the Forester of the North Carolina Geological and Economic Survey to be posted at their stations in the vicinity of forest lands. Any railroad company willfully violating the requirements of this act shall be deemed guilty of a misdemeanor and be punished by a fine not exceeding one hundred dollars for each offense, and railroad employees willfully violating the requirements of this section shall be guilty of a misdemeanor and shall be punished by a fine of not less than five dollars nor more than fifty dollars. But this section shall not be construed to prohibit or prevent any railroad company from piling or keeping upon the right-of-way crossties or other material necessary in the operation or maintenance of such railroads.

Sec. 7. No person shall willfully, negligently, carelessly, or in any manner set fire to or burn or cause to be burned, any waste land, brush land, or forest land, but nothing in this section shall be interpreted to forbid any person from setting a back fire, a ground fire, or a surface fire upon his own property to protect the same: *Provided, however,* if such fire be permitted to escape, or does escape to adjoining property, then the person setting such fire, or causing it to be set, shall be deemed to have violated the provisions of this section. Any forest warden, however, shall have the power to set, or direct to be set, any back fire.

Sec. 8. In a prosecution for the willful or negligent setting fire to woodland, when the evidence has been conclusive as to the guilt or innocence of the party or parties charged with the crime, it shall be within the discretion of the court to take evidence as to the costs of fighting the fire which the accused is charged with setting, and it shall be within the discretion of the court to assess such costs as a part of the penalty of the person or persons charged, if he shall be found guilty.

Sec. 9. Nothing in this act shall be construed as affecting the right of action for damages. The liability of persons or corporations for all damages shall include the injury to young growth resulting from fires.

Sec. 10. Four or more owners of timber lands or other woodlands in any one township, or the owners of one-third of the woodland in the township, can petition to the State Geologist for the appointment of a Forest Warden for that township and, after such appli-

cation, a Forest Warden may be appointed by the Governor to serve at his discretion, and such Deputy Forest Wardens as may be deemed necessary can be appointed by the State Geologist to act with the Forest Warden in any such township.

Sec. 11. Forest Wardens shall have charge of measures for controlling forest fires; they shall make arrests for violations of the forest laws; shall post copies of the forest fire laws and warnings against fires, which shall be supplied by the State Geologist or Forester of the North Carolina Geological and Economic Survey; and they shall perform such other duties as shall be considered necessary by the Geological Board for the protection of forests.

Sec. 12. All able-bodied male persons between eighteen and forty-five years of age can be summoned by Forest Wardens or Deputy Forest Wardens to assist in extinguishing forest fires. Persons when so summoned shall be paid for their services in extinguishing fires at the rate of fifteen cents per hour, and the total amount which may be expended in any one township shall be limited to one hundred dollars in one year. Any person summoned by a Forest Warden or his deputy and not attending, without sufficient excuse to the Forest Warden, shall be subject to a fine of five dollars in a suit brought by the Forest Warden or his deputy before any magistrate.

Sec. 13. Forest Wardens and Deputy Forest Wardens shall have the same power as Deputy Sheriffs so far as the provisions of this act are concerned. Neither Forest Wardens nor their deputies shall be liable for trespass while acting in the performance of their duties, nor shall any person be held guilty of a trespass for going on land when summoned by an officer to control a fire.

Sec. 14. Forest Wardens and Deputy Forest Wardens shall be paid at the rate of twenty cents per hour for the time actually engaged in the performance of their duties, according to an itemized statement rendered the State Geologist or Forester of the North Carolina Geological and Economic Survey every month and approved by him, and the State Geologist, upon warrant of the State Auditor, out of any moneys in the State Treasury not otherwise appropriated or out of the Forestry fund. Forest Wardens shall render to the Board of County Commissioners of the county in which the fire occurred a statement of the services rendered by the men employed by them or their Deputy Wardens, as provided in this act, within one month of the date of such service, which said bill shall show in detail the

amount and character of the services performed, the exact duration thereof, the name of each person employed, and all disbursements made by said Forest Wardens. If said bill be duly approved, it shall be paid in such manner and by such official as other bills of said county are paid. A certified copy of all bills paid in accordance with this section, with evidence of payment, shall be filed with the State Geologist. On approval of said bill by the State Geologist, one-half of the said amount shall be repaid said county by the State Treasurer, upon warrant of the State Auditor, out of any moneys in the State Treasury not otherwise appropriated: *Provided, however*, the State shall pay the entire cost of extinguishing fires originating on and restricted to State lands, and such bills shall not be presented to the County Commissioners, but certified to the State Geologist directly: *And, provided further,* that in no case shall the State's share of any bill be based upon a higher rate for services than as fixed above.

Sec. 15. The Forest Warden of the township in which a fire occurs shall, within ten days, make such report thereof to the State Geologist as may be prescribed by him. Each Deputy Forest Warden shall promptly report to Forest Wardens any fire in his district.

Sec. 16. For the purposes of this act woodland is taken to include all forest areas, both timber land and cut-over land, and all second-growth stands on areas that have at one time been cultivated.

Sec. 17. All laws and clauses of laws in conflict with this act are herewith repealed.

Sec. 18. This act shall be in force from and after its ratification.

Wood-using Industries.

As such a large part of North Carolina's wealth is invested in timber land and wood-using industries, and realizing the growing shortage in the supply of timber suitable for the use of these wood-using industries and the consequent gradual modification in the requirements fixed by these consumers, and recognizing the value both to the producers and consumers of timber of a more intimate knowledge of local market conditions, the State Survey has made a statistical study of the wood-using industries of the State.

This study was made in co-operation with the Forest Service of the United States Department of Agriculture according to the following agreement:

UNITED STATES DEPARTMENT OF AGRICULTURE FOREST SERVICE.

FOREST PRODUCTS CO-OPERATIVE AGREEMENT.

Project Title. Statistics. (Wood Uses) N. C. Project No. 2.

The Forester, of the Forest Service, United States Department of Agriculture, and the State Geologist of the North Carolina Geological and Economic Survey of Chapel Hill, Orange County, State of North Carolina, do mutually agree as follows:

1. The Forest Service, in conducting investigations to ascertain practical methods for the utilization of forest products, and to disseminate a knowledge of their best use, shall co-operate with the State Geologist of the North Carolina Geological and Economic Survey in making a statistical study of the wood-using industries of North Carolina. The study will give the following kinds of information concerning each industry: (a) the products manufactured; (b) the field of trade; (c) the form in which raw material of each kind of wood is desired at the factory; (d) grades of material required for the different uses; (e) smallest sizes that can profitably be purchased; (f) kinds of wood and for what used; (g) amounts used annually; (h) cost f. o. b. factory; (i) source of material.

2. The Forester shall make such preliminary reports as are necessary during the study, and at the termination of said study shall report to the said State Geologist of the North Carolina Geological and Economic Survey the results obtained, with his recommendations.

3. The Forester shall also (a) prepare a list of the wood-using establishments in the State; (b) prepare and print inquiry cards; (c) prepare and print a circular letter to accompany the cards; (d) send out and receive inquiry cards; (e) send out second requests to delinquents; (f) make a personal canvass in Eastern and Piedmont North Carolina of factories delinquent after second request; (g) compile and write report.

4. The said State Geologist of the North Carolina Geological and Economic Survey shall (a) procure data during the present study through the extreme western counties of the State from industries not on Forest Service list; (b) make a personal canvass in Western North Carolina of factories delinquent after the second request; (c) review the written report; (d) publish the report as a state bulletin.

5. The said.....shall pay to the Fiscal Agent of the Forest Service of the United States at

.....the sum of..... all checks to be drawn payable to the Treasurer of the United States.

6. The said State Geologist of the North Carolina Geological and Economic Survey.....when requested by the Forester, shall report upon the application of results of this agreement.

7. All materials purchased with funds by the said State Geologist of the North Carolina Geological and Economic Survey..... and not consumed, shall be returned to the said State Geologist of the North Carolina Geological and Economic Survey..... when no longer needed in the co-operative work. All materials furnished by the Forest Service, and all notes, manuscripts, etc., which have resulted from the co-operative work and which may be desired by the Forest Service, for record or publication, shall be retained by the said Service.

8. This agreement may be dissolved by either party upon ten days' notice given to the other.

9. No member of or delegate to Congress shall be admitted to any share or part of this agreement, or to any benefit to arise thereupon. (U. S. Rev. Stat., 3739-3742.)

10. No person undergoing a sentence of imprisonment at hard labor imposed by any court of the several States, Territories or municipalities having criminal jurisdiction, shall be employed in the performance of this contract. (Executive Order, May 18, 1905.)

Executed this 26th day of August, 1909.

JOSEPH HYDE PRATT,
Co-operator State Geologist.

.....,
Assistant Forester.

The wood-using industries of North Carolina may be divided into three classes: (1) Those taking timber in the log and by the usual operation of the sawmill converting it into rough lumber; (2) those manufacturing directly from the log a finished product which can not be changed by any further process of manufacturing, such as staves, excelsior, shingles, veneer boxes, or mine rollers; and (3) those using rough lumber and by the application of skilled labor and the aid of wood-using machinery convert it into such finished products as furniture, boxes, flooring, etc. The wood-using industries which come under the first class were not included in the study.

This report has been published as Economic Paper No. 20 on "Wood-using Industries of North Carolina," and was compiled by Roger E. Simmons under the supervision of J. S. Holmes, Forester of the North Carolina Geological and Economic Survey, and H. S. Sackett, of the United States Forest Service. This report should be of value to the State in assisting her in forming an independent forest policy, and in presenting the advantages the State offers to wood-using industries to locate in it. The timber owner—even the farmer who has a few scattered trees to sell—can learn from this report where a market can be found. The sawmill operator may learn a new use for a wood which he previously considered of little commercial value. The manufacturer will have a source of fairly accurate information concerning a region most likely to supply the lumber he needs. The merchants throughout the country who handle wood products can obtain considerable advantage in buying and selling. There is given in the report the uses of the different kinds of wood that grow in North Carolina and as complete list as possible of manufacturers who use wood.

Examination of Forest Lands.

The examination of private forest lands at the request of the owners for the purpose of recommending improved methods of management is an important part of the State forest work, and considerable time of the Forester has been spent in such examinations, which it is believed have been of much value to the owners.

The following examinations of forest areas have been made by the Forester of the North Carolina Geological and Economic Survey

1. Report on the Connelly tract of 4,500 acres, near Black Mountain, Buncombe County, by J. S. Holmes.
2. Report on the forest area of the Transylvania State Test Farm, by J. S. Holmes.
3. Report on the forest area of the National Farm School, Tryon, Polk County, by J. S. Holmes.
4. Report on the forest area on the Buncombe State Test Farm at Swannanoa, by J. S. Holmes.
5. Report on the forest area on Iredell State Test Farm, by J. S. Holmes.
6. Examination of woodlands of Salem Academy and College, Salem, N. C.
7. Examination of woodlands of Patterson Farm School, Yadkin Valley, Caldwell County.

8. Examination of the city watershed of Marion.
9. Examination of the city watershed of Lenoir.
10. Examination of the woodlands belonging to Major W. A. Graham, Lincoln County.

As this is the first year that this work has been undertaken by the State Survey, a number of the reports that it has made on these forest areas are included as part of this report, and also form of agreement.

FORM OF AGREEMENT FOR EXAMINATION OF FOREST LANDS.

It is agreed, this.....day of....., between....., called hereafter the party of the first part, and the North Carolina Geological and Economic Survey, known hereafter as the party of the second part:

A. That the party of the second part will have made, either by its Forester or other competent Forest Engineer, an examination and report upon.....acres of forest land belonging to the party of the first part, situated in..... County, N. C., and lying..... This report is to be a *general detailed* working plan containing:

1. A description of the property.
2. A description of the character and quality of the timber.
3. Methods of forest management adapted to the development of the property.
4. Recommendations for methods of lumbering and development.
5. Earning value of the property under proposed system of management.
6. Suggestions for contracts for sale of timber.

B. Upon the completion of this report, the party of the first part agrees to reimburse the party of the second part for all field expenses incidental to making such examination and report, embracing transportation to and from the property, use of private conveyance when necessary, board and lodging, material, laborer's hire, and other necessary expenses other than salary of engineer. An itemized statement of all such expenditures shall be submitted by the party of the second part to the party of the first part, who agrees to pay the same before the delivery of the report and working plans of the property; and upon such payment, the party of the second part agrees to deliver the report and working plan already prepared.

C. The adoption or following of the recommendations of the working plan is in no way obligatory upon the party of the first part.

D. At any time after making this report and while the party of

the first part remains owner of the property, the party of the second part shall have the right to enter these premises and make measurements or calculations of the results of cutting upon the value of the property, and if desired, to publish such measurements, together with all or part of the original report.

.....(Seal)

Witness:.....

.....(Seal)

Witness:.....

Report on Connally Tract, Buncombe County, N. C.

BY J. S. HOLMES, FORESTER.

General Description.—This property, which consists of about 4,500 acres, lies on both sides of North Fork of Swannanoa River, in eastern Buncombe County, and about six miles north of Black Mountain Station, on the Southern Railway.

The land is rough and mountainous and rises rapidly in elevation above sea level from 2,500 feet along the stream to 5,400 feet on the tops of the highest ridges.

Only about 130 acres, scattered about in several small fields, is cleared; the rest of the property is covered with a varying stand of the mixed hardwoods common to this region.

The rock, which is the usual gneiss and schist common to the southeastern Appalachians, outcrops frequently, and in some places loose fragments are very plentiful; but in very few places is the ground too rough to log with comparative ease.

The soil is for the most part a sandy loam, and except in the more level coves, is comparatively poor. Owing to the infrequency of forest fires for the past few years, leaf litter is fairly abundant, being held in place, even on the steep slopes, by the galax and other perennial herbs and by the abundant underbrush. On the poorer slopes this underbrush consists of a dense cover of kalmia and other shrubs, but on the more favorable situations much thrifty reproduction is mixed with the more common deciduous shrubs. In many of the coves, especially where cutting has been done in the past, reproduction of yellow poplar is quite abundant, showing what may be reasonably expected under a better system of management. On the drier slopes chestnut and chestnut oak sprouts, that have come in since the last surface fires, look fairly vigorous and healthy.

In spite of the great variation in elevation, there is comparatively little variation in the proportion of the species composing the forest. Chestnut is the prevailing species and forms from forty to sixty per cent of the timber over the entire property. Chestnut oak is second in abundance and comprises from fifteen to thirty per cent of the timber. Yellow poplar is scarce in some coves, but is abundant in others, varying from five to fifteen or twenty per cent of the merchantable part of the forest. This variation is due as much to previous culling as to any natural difference in distribution.

The rest of the stand consists of small proportions of red oak, linn, buckeye, hickory, locust, black gum, cucumber, white oak, maple, and other species. This tract is generally recognized as one of the best tracts of timber in the county. Though it has been culled to some extent for a great many years, especially in the more accessible parts, there is still a good deal of fine timber on the tract. This is more particularly true of the poplar, which is in such a satisfactory and profitable condition that it will pay best to hold it as an investment.

The chestnut and chestnut oak is largely old, over-mature timber, and would yield for the most part, if sawed up, only second-class lumber.

Wishes of Owner.—The owner desires to hold this tract permanently as an investment. She wishes to handle it according to the best forestry methods, so that the value of the forest will gradually increase, and at the same time she wants to get some decided income from the property.

Management.—A scheme of management must include the following:

I. Sale and removal of mature timber;

II. Provision for a second crop from the immature trees now on the ground;

III. The insurance of a full stand of reproduction of the most valuable species over the whole area; and

IV. The protection of the forest from fire, stock and trespass.

I. *Sale of Timber.*—The salable material now on the tract can be divided into four general glasses: (a) the chestnut; (b) the chestnut oak; (c) the yellow poplar; (d) all other species suitable for saw timber.

a. Chestnut.—Taking the tract as a whole, the over-maturity of

the chestnut is most noticeable. Only in Ten-acre Cove and the upper part of Long Branch Cove is there any considerable amount of young and thrifty pole timber of this species, and over the latter area it is mostly about mature and can be harvested at any time when the markets are favorable. But the old, dead-topped trees, the fire-scarred trees, the crooked, suppressed and stunted ones, and all old trees over pole size (10″—18″ in diameter) should be removed as soon as a sufficiently attractive offer is received. These trees are deteriorating faster than they are growing, and only the prospect of a very considerable rise in price of the chestnut products in the near future would warrant holding this timber at the expense of the young growth that should now be taking its place. The forest would be greatly benefited by the removal of this timber, because the thrifty, fast-growing young growth of chestnut and poplar would take the place of the old growth, which is decaying faster than it is growing.

During a hurried examination no attempt was made to estimate the amount of chestnut timber standing on the tract. In spite of the fact that much of the best timber of this species has been removed from the more accessible parts for fence rails, lumber or other purposes, there is still a large amount of this wood on the property. Most of it would only make a very low grade of lumber or none at all, and under present conditions can only be used for tannic acid extract wood. For this there is a good market, though the price fluctuates somewhat. At the time of the examination the price was a little off, but there seems to be no reason why it should not recover itself before the winter is over.

On the other hand, it seems unlikely that the price will advance to any considerable extent during the next two or three years. It is now being cut and brought to market faster than the manufacturers want it, and they lower the price just to shut off the wood somewhat. Again, many companies hold a large reserve of chestnut wood and timber, for the time when it shall get scarcer.

For these reasons it is recommended that part or all of the chestnut timber be sold in the near future.

Whether part or all of it is sold at the same time, it is strongly recommended that it be cut in the following order:

1. Sugar Fork Cove. This is probably the largest of the five divisions, and the chestnut now on it needs cutting the worst. It is

also the most accessible of all, a large stream, large enough to fill a flume, running from one end to the other of it. If for any extraneous reason, as for instance, to preserve the fishing, it is thought best not to cut this area for the present, cutting should begin with the second area.

2. The Big Cove. Probably sixty per cent of the timber on this area is chestnut. It is over-mature, dead-topped, and fire-scarred, and very nearly all of it should be cut. This area will not be as easily logged as Sugar Fork, because the stream is smaller and all the upper part is without fluming water, so if sold by itself it is probable that a less price would be realized.

3. Chestnut Cove is smaller than Big Cove, but the timber is in about the same condition. These two coves might be handled as one proposition if preferred.

4. Long Branch Cove presents two different conditions. In the lower part the chestnut is large and over-mature and should be removed as soon as practicable. Above the orchards, however, the cove seems to have been very severely burnt over fifty to sixty years ago, and the chestnut having started since the fire, is all about that age. This, though quite salable, is in no immediate need of cutting, as it is largely thrifty and healthy. When harvested it will furnish a great many poles, generally the most valuable form in which chestnut can be put on the market.

5. The area that needs cutting the least and that should be left to the last is the Ten-acre Cove. The chestnut here is healthy, and a large part of it is young and thrifty. It would make many poles now, but it can much better be left to grow than any other part of the tract and will be growing into more money right along, at least for ten years to come.

The chief things to be insisted on in cutting the chestnut are:

1. All old, dead-topped, dead and damaged trees, all crooked and fire-scarred trees of whateever size, and all twisted trees must be cut, also all down trees sound enough to make acid wood.

In order to give the purchaser some inducement to handle all the old chestnut, it might be necessary and advisable to reduce the price on the badly twisted trees or even let them go for nothing. It may also be hard to get them to take all the crooked trees without some reduction in price.

2. All young, straight, thrifty trees, suitable for poles and such as will grow into poles must not be cut.

3. The chestnut must be cut from all over the area designated; the purchaser must not be allowed to leave that which is more remote.

b. Chestnut Oak. Probably 20 per cent of the timber on the entire tract is chestnut oak. This is also mostly over-mature, and its removal would improve the condition of the forest. There is, however, as yet little market for the timber of this tree, and the price of the bark is almost sure to increase considerably within a few years time. The harvesting of the crop is, in addition, an entirely separate operation to cutting the chestnut, and can not well be combined with it. For these reasons it is thought best that the chestnut oak be held till all or nearly all of the chestnut has been cut, at any rate till there is a better demand for the wood and a more satisfactory price for the bark.

c. Poplar. The most valuable timber on the tract is the poplar. Probably ten per cent of the merchantable timber is of this species. It is scattered over nearly all the area, but is more abundant in the coves, especially in Ten-Acre Cove.

There are two very strong reasons why this timber should not be cut till after both the chestnut and chestnut oak have been removed. These are: First, the greatly increasing scarcity and hence increasing value of poplar, which makes it the most profitable timber to hold as an investment; and second, and most important, the future value of the forest depends on these trees being left to seed up the openings made by cutting off the chestnut and chestnut oak. Chestnut and poplar are the two most valuable trees to grow on these lands, and reproduction of these two species is absolutely necessary. Chestnut will come up abundantly from the stumps of the old trees, but poplar must be seeded, and the only way to do this is to have seed-bearing trees scattered over the tract. When the open areas are restocked the old poplar trees may be removed.

d. Other Species. Besides the above there is a small percentage of merchantable linn, buckeye, hickory, maple, locust, red and white oak, and some other species, which are suitable for lumber. There is, however, scarcely enough of this to enable a purchaser to remove it profitably by itself, at least under present conditions.

This timber could probably be cut and handled most profitably with either the chestnut oak timber or the yellow poplar. As the

areas now occupied by these trees should by all means be seeded up as much as possible to yellow poplar, it is strongly recommended that the poplar be left till the last, and that the miscellaneous species be cut at the time when the chestnut oak is removed. This would also enable the peeled logs of the chestnut oak to be handled with greater profit.

e. Contract and Cutting Rules. In making a contract for the sale of timber certain business stipulations will be set forth, among which the following should be included: The area on which the sale is made should be defined and the price per cord, per thousand feet board measure, per acre, or other area which is agreed upon, should be stipulated. The time when operations are to be begun and a limit inside of which they will be completed should be specified. The species, size and condition of trees to be cut should be clearly understood and should be stated in the contract.

Besides these certain rules for logging, etc., should be embodied in the instrument. The following cover the ground pretty well:

1. Only the species and classes specified in the contract may be cut, and all of these must be cut.

2. All sound stumps must be cut as low as possible in order to waste as little timber as possible, and all tops must be used up as close as the markets will allow, for the same reason.

3. In felling timber special care must be taken to break the young, thrifty trees that are to be left as little as possible. If it should be necessary to fell a tree into young growth the least valuable species, such as maple, gum or beech should be chosen in preference to the valuable ones like poplar, chestnut or linn.

4. In logging the reproduction and young growth of all valuable species must be injured as little as possible.

5. Should any poplar, linn or other species not sold be broken down or badly damaged in logging, the owner is to have the privilege of cutting it up into pulpwood or other merchantable form and using purchaser's flume and roads free of charge for getting it out.

6. Only the inferior species must be used for necessary logging purposes, such as construction of skids, slides, bridges, tramroads, flumes, etc.

7. Saw timber for flume construction will be paid for by the purchaser at the rate of ($..... per thousand stumpage).* Chestnut, as well as the inferior species, can be used for this purpose.

*Price to be agreed upon.

8. Right of way for flume or tramroad is given to the purchaser free of charge, but where such crosses a public or private road adequate and satisfactory crossings must be constructed by the purchaser.

9. Fire must be kept out of the woods at all cost. The purchaser will be held responsible up to $1 per acre, plus the value of all merchantable timber destroyed, for any fire occurring on his sale area.

Or this: (9. The purchaser will do all in his power to keep fires out of these woods, and will instruct his employees to make that their first care.)

10. Any violation of this contract will justify its cancellation.

II. *Provision for Second Crop.*—The provision for a second crop of timber from the immature trees now on the ground is made chiefly by the proper removal of the mature timber, which has been treated of above under sale of timber. By thinning out crooked, stunted and suppressed and badly fire-scarred trees, where these can be added to the sale, the remaining thrifty young growth is often benefited. But too much thinning out must not be done or the trees that are left will put out side branches, and the result will be injurious. It is not advisable to thin, as a general rule, unless the material taken out will pay for the operation.

III. *Insurance of Reproduction.*—To insure the fullest and most valuable stand of reproduction over the whole area the following rules should be observed:

a. Sufficient seed trees of the valuable species to seed up the area should be left after most of the mature timber has been removed.

Yellow poplar and ash reproduce almost entirely from seed, so from one to two seed trees to the acre should be left; more if the trees are small or are in hollows; less if they are large or on ridges or high ground.

The nut-bearing trees, oaks, hickories, walnuts, and even chestnuts, reproduce partly from seed and partly from sprouts. The seedling makes the stronger and longer lived tree, but the sprout has a rather more rapid growth when young. A few seed trees of these species might be left with advantage, though this is not necessary during the first cutting.

b. Trees that in our forests propagate mostly from sprout, as chestnut, linn, locust, should not be cut during the late summer,

say from the middle of July to the middle of September, as this weakens the sprouting capacity of the stump. For the same reason where it is desired to lessen the proportion of some species in a stand, as, for instance, scarlet and black oak, these may be cut chiefly through the summer months.

IV. *Protection.*—There can be no satisfactory stand of reproduction and no full second crop from the young timber now standing unless the woods are protected absolutely from fire, and unless the grazing of stock is adequately controlled. Trespass also should be prevented.

a. *Fire Protection.*—Fire has in the past done immense damage to all classes of the timber, but for the past few years it has been much less destructive. Mr. Burnett, the man in charge, is supposed to go through the woods one or two days each week, but through press of other work he seldom does it that often. To improve the system of fire protection on this tract the following recommendations should be carried out:

1. More frequent patrol in dry seasons is advisable. The greatest danger to the woods from fire is during a dry spell, before the leaves come fully out in the spring and after the leaves fall in the autumn. At these times the woodsman should go through the woods three or four times a week. It should be generally known that he does this, but not known when or where he may be expected. This will prevent fires being set, and, besides, should any be set he, being on the ground, will be able to put out fires almost as soon as they start.

2. Fire lines should be constructed around the property, as near the boundary as is convenient. These should follow as much as possible such natural fire lines as the tops of ridges, streams, old roads or trails. They should be cleared of brush and leaves enough to enable a man readily to stop a fire, either directly or by back firing from it.

3. Trails that are already made should be kept open, and others should be made. These would enable the woodsman to get more easily all over the property, and would also act as fire lines in case of necessity.

After logging commences trails and roads will be constructed to get out the timber. These should be kept open as much as possible after the logging is over, as they will make very satisfactory fire lines.

4. The posting of notices, warning against forest fires, has been found of great assistance toward protection, both on the national forests and on many private tracts in this country. It is strongly recommended that such notices be put up along all roads and trails and in other conspicuous places on the property.

Three different styles of notice are recommended, one or more of which can be used. (a) A clause against burning the woods may be inserted in the ordinary trespass notice, of which the owner has from time to time put up a few on her land. (b) A special fire notice, requesting all neighbors and those who pass over the land to actively co-operate with the owner in the prevention and extinguishing of forest fires. (c) A warning against setting fires on this and adjoining property, quoting the section (3346) of the laws of North Carolina dealing with this question. Such notices should be printed on heavy cloth and could be made by local presses at from 50 cents to $1 a dozen or from $2 to $3 per 100 for the 12 x 18-inch size.

b. *Protection from Stock.*—Fortunately Buncombe County is under the operation of the stock law, so there is little risk of damage from the neighbor's stock. Cattle injure the woods seriously, especially during and after logging, when they break and browse on the linn shoots and the poplar seedlings. They should, therefore, be kept out till reproduction of these species grows out of their reach.

There are some hogs now running in these woods with the connivance of the owner. They eat up the chestnut, oak and hickory seed, and so long as it is desired to encourage this kind of reproduction they should be kept out. After a sufficient proportion of these species is secured in the reproduction, and just before and during the cutting of the poplar, the hogs might be allowed in the woods, for then the laying bare of the mineral soil, which favors the germinating of the poplar, may compensate for the destruction of other seeds.

c. *Trespass.*—The owner of this property has had trespass notices printed and posted, but very few of these were noticed during the examination. More of them should be put up, especially along roads, trails and streams and along the boundaries of the tract.

The woodsman, Mr. Burnett, should be furnished a map or plan of the property. He is not familiar with all the lines, especially with those of the interior holdings, so that he can not be sure whether a tree is cut in trespass or not. Any line, the location of which is uncertain, should be run out and marked by a competent surveyor.

RECAPITULATION.

1. The owner wishes to receive some revenue from this property and at the same time wants to increase the value and permanent productivity of the forest.

2. The merchantable timber on the tract is of four classes—chestnut, chestnut oak, poplar and miscellaneous species.

3. About half the stand is chestnut, which consists, for the most part, of old, dead-topped, over-mature trees. By cutting these out great benefit would result to the forest. The greater part of this chestnut would not make good lumber, but could be sold for tannic extract wood. It would have to be taken to market by a flume or tramroad. When sold the different areas should be cut in the following order: Sugar Fork Cove, Big Cove, Chestnut Cove, Long Branch Cove, Ten-Acre Cove.

4. About twenty per cent of the timber is chestnut oak. This is over-mature and its removal would benefit the forest, but market conditions would make it advisable to hold it till after the chestnut has been cut.

5. The most valuable timber on the tract is poplar, amounting to about ten per cent of the stand. Its permanent market value, as well as its great value for seed trees, make it most advisable to hold the poplar till both the chestnut and the chestnut oak is removed.

6. There is quite a lot of miscellaneous merchantable timber which should be cut at the same time either as the chestnut oak or the poplar. The former is strongly recommended.

7. In a contract of sale, besides stipulating the price, species, area of sale and kind of timber sold, certain rules for logging, to prevent waste and protect the young growth and reproduction, should be inserted.

8. In the scheme of management provision must be made for a future second crop of timber from the young growth now on the ground.

9. Seedling reproduction must be encouraged by the leaving of seed trees, and sprout reproduction by cutting the timber at the proper season of the year. Both kinds must be protected during logging, also from fire and stock.

10. Adequate protection of the woods from fire is the most essential part of forest management. This may be secured by patrol, by the construction of fire lines, trails, etc., and by the posting of notices.

11. Protection of the woods from stock is advisable, more especially during and following logging operations.

12. Very little trespassing seems to take place on the property, but the woodsman should be made familiar with all the boundaries of the property.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

List of Trees, and Some Shrubs Noted on the Connally Property, Buncombe County, N. C., in the Order of Their Importance.

Common Name.	*Botanical Name.*
Chestnut	*Castanea dentata.*
Chestnut oak	*Quercus prinus.*
Yellow poplar	*Liriodendron tulipifera.*
Linn (basswood)	*Tilia americana.*
Linn (white basswood)	*Tilia heterophylla.*
Red oak	*Quercus rubra.*
White oak	*Quercus alba.*
Red maple	*Acer rubrum.*
Sugar maple	*Acer saccharum.*
Scarlet oak	*Quercus coccinea.*
White ash	*Fraxinus americana.*
Mockernut hickory	*Hicoria alba.*
Pignut hickory	*Hicoria glabra.*
Bitternut hickory	*Hicoria minima.*
Locust	*Robinia pseudacacia.*
Buckeye	*Æsculus octandra.*
Black birch	*Betula lenta.*
Yellow birch	*Betula lutea.*
Cucumber	*Magnolia acuminata.*
Black gum	*Nyssa sylvatica.*
Black cherry	*Prunus serotina.*
Beech	*Fagus atropunicea.*
Sassafras	*Sassafras sassafras.*
Dogwood	*Cornus Florida.*
Butternut (white walnut)	*Juglans cinerea.*
Black walnut	*Juglans nigra.*
Hemlock	*Tsuga canadensis.*
Mountain magnolia	*Magnolia fraseri.*
Service	*Amelanchier canadensis.*
Sourwood	*Oxydendron arboreum.*
Ironwood	*Ostrya virginiana.*
Red cherry	*Prunus pennsylvanica.*
Striped maple	*Acer pennsylvanicum.*
Mountain maple	*Acer spicatum.*
Kalmia	*Kalmia latifolia.*

Common Name.	*Botanical Name.*
Rhododendron	*Rhododendron maximum.*
Rose rhododendron	*Rhododendron catawbiense.*
Cornel	*Cornus alternifolia.*
Witch hazel	*Hammamelis virginiana.*
Mountain leucothoe	*Leucothoe recurva.*
Stagger bush	*Xolisma ligustrina.*
Sweet mountain pepper bush	*Clethra acuminata.*
Alder	*Alnus rugosa.*
Pink azalea	*Azalea nudiflora.*
Flame azalea	*Azalea lutea.*
Winterberry	*Ilex verticillata.*
Mountain holly	*Ilex monticola.*
Spice bush	*Benzoin benzoin.*
Menziesia	*Menziesia pilosa.*
Maple leaved arrowwood	*Viburnum acerifolium.*
Wild hydrangea	*Hydrangea arborescens.*
Flowering raspberry	*Rubus odoratus.*
High bush huckleberry	*Vaccinium corymbosum.*
Black sumach	*Rhus copallina.*
Smooth sumach	*Rhus glabra.*
Poison ivy	*Rhus radicans.*
Virginia creeper	*Parthenocissus quinquefolia.*
Virgin's bower	*Clematis virginiana.*
Grape	*Vitis sp.*
Green briar	*Smilax rotundifolia.*
Dutchman's pipe	*Aristolochia macrophylla.*

Report on the Transylvania County State Farm.

BY J. S. HOLMES, FORESTER.

The Transylvania County State Experiment Farm is situated at Blantyre, a small station on the Toxaway branch of the Southern Railway, on the boundary line between Henderson and Transylvania counties.

It consists of about 240 acres, only one-fifth of which is cleared. Of this cleared land about 25 acres is rich bottom land lying on the French Broad River, and extending right up to the Blantyre station. The other 20 acres consists chiefly of comparatively recently cleared upland, most of which has been set out in fruit trees. Some of this land is quite steep, leading one to suspect that when the roots of the trees have rotted out of the soil the danger from erosion may be serious.

The woodland occupies for the most part the steeper and more infertile slopes. The soil, which is a red clay loam, decomposed

from the gneissic rock of the region, is fairly fertile when first cleared, and produces crops for three or four years, after which it is rapidly impoverished by erosion.

Object.—The object of the State Department of Agriculture is to make the woodland as profitable and instructive a part of the farm as the cleared land is intended to be.

The greatest problem before our mountain farmers is to determine for what purpose each part of their land is best adapted, and then put to its best, its most profitable use. Much of the mountain land is "absolute forest land," that is, it will be more profitable in the long run to keep it growing timber crops than to clear it for agriculture. To determine what sort of land should be cleared and what should be kept in woods, in order to yield the greatest permanent revenue, seems to be one of the most important questions a mountain experiment farm can attempt to solve. This, and to determine what is the best method of handling the mixed hardwood common to the region, and to form an object lesson in improved forest management, should be the main objects in the management of these woodlands. It is thought best that very little more land be cleared on the property, unless absolutely needed, until it can be shown that erosion, which on steep land is so destructive, can be controlled, so that this land can profitably be kept permanently in cultivation.

The Forest.—The forest consists of a very heavily culled stand of the various hardwoods common to the region, chestnut, black oak, white oak, chestnut oak, yellow poplar and hickory being the most important species. This forest growth can be readily divided into three size and age classes: (1) The large, old, mature and over-mature trees; (2) the smaller, mostly second growth trees, most of which are not large enough for merchantable lumber; (3) the seedling and sprout reproduction.

1. The old, over-mature trees are as a rule growing very slowly, if at all, and are retarding the more profitable and vigorous growth of the younger and smaller trees, so that as soon as the market will enable the cost of removal to be paid by the receipts they should be cut, even though no clear profit can be realized in handling them. A process of culling has been going on almost continually over this tract till, at the present time, there is practically no timber left that would make salable lumber. The mature growth consists of old,

dead-topped, doty chestnuts; gnarled, crooked, hollow or spike-topped chestnut oak; knotty, wormy or broken black or white oak, and a few scattered, crooked or hollow poplar. Some few hickory, black gum, red maple and scarlet oak, that would make a rough grade of lumber are found, but it would probably pay better to cut most of these into firewood. All the old chestnut should be worked up into extract wood, which brings about $4 per cord at the station close by. There are also some dead trees and some down logs that can be cut up and sold for this purpose. The smaller, crooked, suppressed and dead-topped chestnut can also be cut up for extract wood, but the straight, thrifty trees of this species should be left standing, as they are rapidly increasing in value.

There are some few chestnut oak still on the property that will produce some bark. This should be cut and peeled next spring, then the wood could be cut for firewood the following winter.

There are a good many trees lying on the ground that were peeled three or four years ago. These should be cut up into firewood as closely as possible. All down timber is a menace from fire, and should be removed from the woods whenever possible.

The old oak, hickory, maple and black gum should be cut for firewood unless some few could be marketed more profitably as saw logs. The first object of management is to get rid of these old trees.

2. The young, thrifty growing trees, say from three to fifteen inches in diameter, must be saved for the next crop of timber, and must be given every chance to grow rapidly. All crooked, stunted or badly injured specimens should be taken out and used for firewood or chestnut extract wood, as the case may be, to make more room for the healthy trees and the reproduction. Young chestnut trees that might now make small poles should rather be reserved for a few years to furnish seed and to make the forest growth more profitable.

3. Reproduction is excellent over a good part of the tract. Poplar seedlings form almost a dense stand in many places, and chestnut, oak and hickory sprouts are plentiful and healthy. Not only must this be fostered and protected as carefully as possible, but provision must be made to procure an adequate stand wherever the old trees are removed. For this purpose some of the old poplar trees should be left standing so that plenty of poplar seed may be assured. Poplar and chestnut, which reproduces mostly by sprouts from the stumps,

are the most valuable species, and the larger proportion of these two species that can be secured in the next crop the more valuable will be the property.

Fire.—There seems to have been little or no fire over the greater part of this woodland for several years past. The consequence is that there is in many parts abundant reproduction, which is in a very healthy condition. There is also a good ground cover of leaves and twigs, which prevents erosion and fertilizes the soil.

Every effort should be made to keep fire out permanently by impressing the importance of it on all the neighbors as well as those that work on the place. Notices printed on cloth and posted in conspicuous places, calling attention to the importance of keeping fire out, would, without doubt, prove very effective.

Conclusions.—The woodland part of this farm should be handled as an experimental and demonstration tract, to ascertain how much of the mountain land is absolute forest land and to show to all who visit it some improved methods of forest management.

2. As little land as possible should be cleared for the next few years, till it can be shown that it will be more profitable to do so.

3. All the old, dead-topped, over-mature trees, for which a market can be found, should be cut out, except those old poplars that are wanted for seed trees.

4. The crooked, suppressed and badly fire-scarred trees should be thinned out from the second growth wherever such operation can be made to pay for itself.

5. Reproduction should be encouraged in every way possible, by taking out the large old trees, by leaving seed trees of the most desirable species, and by protecting the forest from fire.

Approved: J. S. Holmes, *Forester.*

Joseph Hyde Pratt, *State Geologist.*

Progress Report on the Transylvania State Experiment Farm, September, 1910.

BY J. S. HOLMES, FORESTER.

Since my examination of the experiment farm last year a thirteen-acre tract of mountain land has been added to the farm. This is a rough, ridgy area on the west side of the property, three or four acres of which have been cleared in two small hollows; the rest of the tract is woodland which has been very heavily culled, little merchantable timber having been left on it. Most of this tract is pine

forest land, and should be handled in the same way as, and in conjunction with, the woodland on the rest of the property. There are several dead and dying chestnut trees on this addition which should be cut and worked up into acid wood. This wood would have to be hauled two and a half miles to Penrose station, as this would be cheaper than bringing it to Blantyre. A price of seventy-five cents a cord has been offered for the chestnut stumpage, and it is probable that this will be accepted and the wood cut the coming winter. One large poplar tree which has recently been killed by lightning should be cut up and sold for cordwood or for saw timber. The cleared land on this tract will probably be seeded down and used as pasture; it should, however, be fenced off from the woodland, as no benefit can result from pasturing in the adjoining brush land.

Some work has been done on the woodland of the original property during the past year. Two or three carloads of chestnut wood has been cut from the over-mature trees and shipped; the cutting seems to have been well done, no injury resulting to the surrounding young timber. Something over three hundred dollars worth of poplar squares were cut from the mature and over-mature poplar trees the past winter, the farm clearing fifty per cent of this amount on the operation. The tops of these trees are still lying in the woods; they should, this winter, be cut into cordwood and sold for pulp. These old poplar trees had in most cases passed their usefulness, having restocked the surrounding areas with young poplar trees; they were ready to cut, and it was in conformity with the previous recommendations that they were removed. There is, however, considerable risk in disposing of all the seed trees of this valuable species. Should the woods burn over the young poplars would be destroyed, and, with no seed trees to restock it, irretrievable damage might be done. It is, therefore, strongly recommended that no more live poplar trees be cut until the property is made more secure against fire.

Two serious fires occurred on the property during the past winter and spring. At the end of November the ridge on the northwest corner of the property was burnt over and nearly all of the young growth and reproduction was killed and all live timber seriously injured. This area, comprising about four acres, had not been burnt over for many years. In addition to this area the fire spread onto the thirteen-acre tract recently purchased and burnt over about one-

third of it, inflicting serious injury. Two dollars and fifty cents was spent in fighting this fire besides further assistance from the neighbors, which was not paid for. This fire was supposed to have been purposely set by the operatives of a sawmill, which was sawing on a near-by property, to burn the leaves so that the logging would be made easier.

The second fire occurred in the late spring. It was set purposely, by some unknown person, in three or four different places, two of which were on the test farm, one on the thirteen-acre tract, now part of this property, and one place on a neighbor's land close to the boundary. It was thought that it was done by some one who wanted to hunt on the place and found the leaves and young growth too thick to make hunting easy. There is no evidence as to who this party was, but suspicion falls on a family who are known to be fond of hunting and who rarely do anything else. This fire, though set in a very dry time and in the driest part of the day, did but little damage to the test farm woods, as Mr. Blythe, the foreman, successfully fought it off the property at a cost of a little over three dollars. One acre on a north slope was burnt over and about two-thirds of the thirteen-acre tract.

The causes of these fires should be looked into and every effort made by the State to convict the guilty parties. No system of forest management can be successful unless fire can be prevented. One or two prosecutions under the present laws, whether they were successful or not, would do a great deal towards protecting the forests, not only in Transylvania County, but in the whole State, and it seems to me to be the plain duty of the State officials to enforce the laws for forest protection. If these are proved to be inadequate the State should then be the first to advocate more efficient laws.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

There have been many requests for such examinations as mentioned above, but it has not been possible for the State Geologist to have these tracts examined on account of the limited funds available for carrying on the forestry work of the Survey.

Examination of Watersheds.

Several applications have been received from municipalities to examine the watersheds from which the city or town obtains its water supply in order to recommend the best method of protecting these watersheds from forest fires and contamination. Thus far only two thorough examinations have been made—one for Marion, McDowell County, and the other for Asheville, Buncombe County.

Report on the Watershed of the City Waterworks of Marion, McDowell County, North Carolina.

BY J. S. HOLMES.

The town of Marion obtains its water supply from Clear Creek, a stream rising on the southerly slope of the Blue Ridge and emptying into the Catawba River. The drainage basin of this stream, amounting to 628 acres, is owned by the town, together with the entire waterworks system. The water-shed is steep and rough, the boundary line (which follows the including ridges) averaging a thousand feet above the stream at the intake. The tract is entirely covered with forest, no part of it having been cleared and but very little timber ever having been removed. The forest is the usual mixed hardwoods of the Southern Appalachians, chestnut and chestnut oak being the predominating species, though some poplar and a little hemlock, linn, buckeye, birch, hickory and red and white oak are scattered over the tract. The forest seems to have suffered little serious injury from fires in recent years, so that the ground cover of leaves and small plants is abundant, which makes ideal conditions for a city water-shed.

The town purchased this land some two years ago from the Burke Tanning Company, of Morganton, N. C., at the price of $7.50 an acre. The intake, which is constructed of reinforced concrete, is 430 feet above the reservoir on the outskirts of the town, which in turn is 230 feet above the business part of Marion. A six-inch iron pipe was laid from the intake, a distance of six miles, to the reservoir, at an approximate cost of $23,000, including the construction of the intake. The reservoir, which has a capacity of 300,000 gallons, together with the city lines and sewers, which are constructed all over the town, has cost approximately $35,000. The whole ex-

pense of this system, which furnishes a supply of 500,000 gallons of water a day, not more than one-tenth of which is now being used, was met by a municipal bond issue of $60,000. Being now possessed of a lavish supply of as pure and good water as any town desires, the city council is extremely anxious to do all in its power to keep the water pure and clear and free from any contamination. They are willing and anxious to spend some money for this purpose, and desire to know in what way the present excellent condition of the watershed can be maintained or, if possible, improved.

By far the most important precaution that can be taken is to protect the whole watershed from forest fires. The cover of leaves and young growth prevents the washing of soil and other foreign matter into the streams and by retarding the run-off, so that practically all the rainfall sinks into the soil, the water is kept clear and the springs are given a regular flow. Wherever fire destroys this leaf cover the ashes and soil wash down into the streams, not only temporarily discoloring the water and filling the reservoirs, but permanently injuring the stream beds by changing the clean, rocky bottom to a sandy or muddy water course. Wherever streams rise and fall with every change in precipitation, the mud along the banks becomes foul in the hot weather, and the water becomes impure. The dense leaf cover not only regulates the flow of the springs and keeps the mud and the silt from the water, but, by making the rainfall sink into the ground instead of rushing directly to the stream, any chance impurities (such as the droppings from stock or even an occasional dead animal) are kept out by the thorough filtration of the water in the soil.

Protection from fire is infinitely more important than protection from stray stock, though it would be well if both could be put into force. The stock law was operative all over McDowell County, but a recent enactment of the Legislature has exempted a considerable area of forest land along the south slope of the Blue Ridge, which allows stock to run at large over this water-shed. Owing to the rugged nature of the country above the intake and the small amount of forage which the cattle might secure there seems to be practically no trespass from stock on the creek side, though some cattle come in across the divide from the other side. There has been some talk of fencing up the property to keep out stray stock. This, however, seems to the writer to be unnecessary and inadvisable at the present

time. A short "drift" fence across the bottom of the cove just below the intake, and extending a short distance up the ridges on each side, would prevent any but the most occasional trespass from stock near the intake; cattle on the far side will do little injury. A fence all around the property (which must have a boundary of some five to seven miles) would be a large expense, and the first fire might temporarily destroy its usefulness and add to its expense by burning down the posts.

An adequate fire line could be constructed all around the property at less expense than a fence, and it would result in infinitely more good to the water-shed. A strip of land twenty feet wide cleared of all inflammable material, such as leaves, dead limbs and trees, as well as, in some places, dense undergrowth, would pretty effectually prevent the spread of fires from the surrounding woods to this tract.

In order to prevent fires being set on the tract itself, and also to prevent indiscriminate trespass, patrol is necessary. At present the superintendent of the waterworks visits the tract once or twice a week, and a man living a short distance below the intake is also paid to look after the property. There are, however, no means of getting over the tract except on foot, over very steep and rough country. A trail should be constructed entirely around the property, not necessarily keeping strictly to the boundary line, but as near it as is consistent with the securing of a grade suitable for the passage of a horse and a rider. This would necessitate starting the ascent on the lands adjoining; but as these, in most cases, belong to large holders, who would no doubt be willing and anxious to co-operate in fire protection, no trouble need be anticipated in getting permission to make a trail over these lands. Once on the top of the ridge the trail would probably follow the divide, and it and the fire line could be made in the same place. From such a trail (which should be traversed daily by a patrol in dry seasons, and periodically at other times) a man could see all over the tract, and any fire that might be started on the tract could easily be discovered and readily extinguished before it had done serious damage.

A telephone line is now in operation to within two or three miles of the intake. This line might very well be extended to the house of the man who is now employed to look over the tract. This would be a great additional protection from fire, and would in other ways add to the security and successful operation of the property.

Trespass notices might be found of considerable benefit in calling the attention of the public to the desire of the city of Marion to protect its water-shed from all forms of trespass. There seems, however, to be little travel of any sort over the property, and unless a change in this respect comes about such notices might do more harm than good. If the use of trespass notices should become advisable they should in all cases contain a distinct warning against setting fire to the woods. Special fire warning notices might also be printed and posted along the boundaries of the tract.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

Supplemental Report on the Marion City Water-shed, McDowell County, N. C.

BY J. S. HOLMES, FORESTER.

December, 1910.

On a recent trip to Marion the Forester inspected the progress of the work on the city water-shed. In accordance with his first report the aldermen had ordered the construction of a fire line entirely around the water-shed, a distance of some five miles, at an estimated cost of $250.

The construction of this fire line, under the efficient direction of the Water Superintendent, had scarcely been begun, however, when forest fire broke out to the east of the tract during a spell of very dry windy weather. The Superintendent fought for four days to try to extinguish the fire, or at least keep it from burning over the water-shed, part of the time having eighteen men to assist him. At one time, after he had succeeded in getting the fire under control, it was again set out by the neighbors with the object of protecting a fence that was used to keep stock from straying into the more settled part of the county, which has had the stock law for some years. If the rough mountain land had been put under the operation of the stock law, as it should have been, when the county was given this privilege, much of the injury and expense of this fire would have been saved and none of the water-shed would have been burnt off. The cost of fighting this fire, which amounted to about $75, was doubled by the undirected efforts of these men to protect their fence with fire at the expense of their neighbor, the city of Marion.

The burning over of the whole water-shed was narrowly averted and only prevented by the unceasing efforts of the Superintendent and his faithful band of fire-fighters. As it was about 100 acres of the water-shed was burnt over, destroying the leaf cover and much of the young growth and reproduction.

Since the fire the work of constructing the fire line has gone steadily on, until at the time of the inspection it appeared to be about half finished. A strip of woods, varying from twenty-five to forty feet wide, had been cleared of brush along the greater part of the boundary which runs along the top of a high ridge or divide. The brush being hardwood and too green to burn readily had been piled on each side of the cleared strip, to be later piled in the middle and burned as soon as it shall have dried sufficiently. Along probably one-quarter of the fire line the leaves had been raked and burnt, leaving a wide strip clear of leaves and brush. The total cost of this fire line so far promises to fall well within the estimate of $50 per mile.

Of the great benefit of this fire line surrounding the water-shed there can be no doubt. The Superintendent declares that had the fire line been completed at the time of the recent fire he would have had no difficulty whatever in controlling it, and could have prevented it coming onto the waterworks property with the aid of half a dozen men or less.

The city authorities are extremely anxious to protect their water-shed from fire; and with this end in view will endorse and push forward any movement to secure more adequate fire laws and better protection for the forest lands of this State.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

Reforestation of Cut-over and Abandoned Farm Lands.

Many hundred thousand acres in all parts of North Carolina now lying either entirely waste or producing scarcely any timber of value can be made to yield to their full capacity and make remunerative returns to their owners. The forest lands that have been cut over once or twice can be made to produce other cuttings as valuable as any that have already been removed. In order to secure reproduc-

tion it is necessary that seed trees should be left on the cut-over lands to furnish the seed required, or else it will be necessary to set out young trees or sow seed brought in from outside. Then there must be adequate protection for the young growth, and fire and stock must be kept out of the area. Besides these cut-over areas there are many thousands of acres, especially in the middle and western portions of North Carolina, which have been cleared for cultivation and proved unprofitable. Whatever may have been the cause for this the lands should be reforested. Where lands of this character do not naturally restock in trees they can profitably be planted in some desirable species. This will not only insure some earning from such land, but it will protect it from washing or deterioration. The following instructions regarding the reforesting of these waste lands will be of value to those who wish to reclaim them.

Kinds of Trees to Plant.—Native trees and those which are naturally adaptable to the soil conditions should be selected for planting. On the uplands of the Piedmont the native pine is a desirable tree, especially for raw and shallow soils. On slopes or where the soils are not so dry or raw the pine might be mixed with the native red oak. On bottom lands which are not too wet, and on lower slopes, poplar and red oak make a desirable mixture, or ash can be substituted for a part of the oak. For planting on wetter lands, ash, walnut and cottonwood are desirable species.

These trees make rapid growth; they root quickly when planted, and they make timber suitable for many farm uses. Second-growth poplar and cottonwood are not held in high esteem in this State. While they are not equal to pine for many uses they nevertheless produce a timber which, when dried, is serviceable for weatherboarding, if kept painted, and for all interior woodwork, except for flooring. The growth of white oak and hickory is too slow for them to be recommended for planting, although young trees of these species should be protected when growing in the forest. Ash and poplar, both of them species of rapid growth, can not be expected to make large trees on ordinary upland soils, and should not be planted except on the best soils, like lower slopes and bottoms. Both black oak and scarlet, or Spanish oak, are inferior to red oak, and for this reason should not be planted.

How to Collect Seedlings.—Young plants raised from seeds in a seed bed and having compact roots are superior to those which are

obtained from the forest. It requires, however, at least two years to grow specimens for planting from the seed, while it is possible at any time to get enough young trees from an old forest or from second-growth woods with which to plant a small area. Red oak and pine will be found abundant near old trees of these species in the uplands. Small poplars will be abundant in second-growth or culled woods on steep north slopes and in hollows, while young ash will be found on wet bottom land. Cottonwood is not a very common tree, and young trees of that species are not common. Slips or cuttings can be taken from large trees of this species, rooted in a garden bed and planted in place of seedling plants, since its cuttings root extremely easily.

Young trees which are dug up for planting should be from one to two feet high. They should be dug up with a sharp mattock or grub hoe, the roots being broken as little as possible, and they should be heeled in a cool place and protected from the sun until ready to plant. When lifted for planting from the trench in which heeled the roots should be kept covered with a wet sack. The hardwoods should be cut back two-thirds, but the pines should not be cut back. Poplars have a long, deep tap-root, so that only small specimens of this species can be taken. Broken and long roots should be cut off with a sharp hatchet, as well as the tap-root.

Preparation of Land.—If the land which is to be planted in trees can be plowed, check it with a broad-pointed shovel plow, with furrows five feet by five feet. Two men can plant to advantage. One man with a mattock makes a hole every five feet at the crossing of the furrows; the other carries the plants in a basket hung over his shoulder, places the plant in the hole, covers the roots and presses the earth tight around the roots with his feet. Roots should be spread out in the hole as much as possible when planted.

When the land can not be checked with a plow poles placed at each end of the field can be used for marking, and the holes dug with a mattock in a line between the poles, the rows being kept straight in one direction by means of them, while the distance can be stepped in the other direction. In fields which are partly stocked with cedar, sassafras, pine or other trees, only the banks or thin places need be planted, the planted trees being spaced about five feet apart in holes dug with a mattock. Red oaks can be planted among sassafras sprouts, and if the sprouts are not too thick the oaks will soon out-

grow them. When two species are mixed in a plantation they should be alternated in the rows.

Time to Plant.—Planting can be done in any mild weather after November 1st, but it is preferable to do it during February and March, especially in the case of pine. It costs too much to cultivate trees after they are planted, and for this reason the larger specimens should be planted in the grassiest and weediest spots, since small specimens might be smothered by such growth. Plantations of trees must not be burned, and cattle must be kept out until the trees are so tall and strong that cattle can not break them.

The Forester has made several examinations of lands and given information regarding how to reforest them. There is given below copies of reports made by the Forester on the care and treatment of the Salem Academy and College, Winston-Salem, N. C., and on recommendations for the artificial regeneration of long-leaf pine on the Pinehurst estate, Moore County.

Report on the Woodlands of the Salem Academy and College.

The Salem Academy and College owns and controls some twenty-five acres of land in the city of Winston-Salem. The greater part of this is now being used for raising feed and providing pasture for the twenty odd head of cattle comprising the dairy herd belonging to the college.

It is desired to reserve certain portions of this property, some of which has only recently come under the control of the college, for park purposes. Most of this part of the property has tree growth on it, which, however, is not all in a very healthy condition.

It is the desire of the management of the college to do all in its power to improve the appearance of this park, by improving the health of the trees, thinning out dying or dead trees or branches, and planting young trees where advisable.

This woodland occupies the steep and broken ground at the back of the college. A small stream runs through the park from north to south. The soil is a fairly rich clay loam, all except a narrow strip along the stream, being very well drained and exceedingly well adapted to the growth of most of our native hardwood trees. There is unfortunately little ground cover of leaves and twigs, and most of the area is sadly deficient in humus.

For convenience in designation and description the area under

discussion is divided into four parts, varying according to their present condition and the treatment that seems to be advisable.

East Slope.—This area slopes almost precipitously from the back of some private gardens to the small stream, and includes a little moist land on the eastern side of the stream. Practically no trees are now on this piece of land, but the soil is kept from washing by a dense cover of turf. The stream should be straightened, and the soil thus drained by the cutting of an open ditch. The planting of willow oak, sweet gum and yellow poplar is recommended along this low land, and of red oak, American linden and yellow poplar along the steep slope. Sugar maple and beech would also do well here if a denser forest is desired.

West Slope.—This area of four or five acres is a remnant of the original forest. It contains many very handsome trees, mostly oaks. A very few of these should be removed at once, and they have been marked for that purpose. A few more can be taken out in a few years time with advantage, when some young trees have been planted and are ready to take their place. Yellow poplar, black walnut, red oak, white oak, willow oak and shagbark hickory may be planted here, the first three on the lower slopes, the others anywhere over the area.

The city proposes to cut a street through the north side of this tract, which will greatly injure the property for the purpose for which the college intends it. If this is done the college proposes to plant a belt of quick-growing trees and shrubs along the south side of the road to shut out the view of the park, thus making it more private for the students. Some fairly rapid-growing evergreens are suggested for this purpose, as loblolly pine, hemlock and Norway spruce. Large trees should be used, as really rapid growth could not be expected under the shade of large forest trees. A few dogwoods, planted in front of these evergreens and at other places throughout these woods, would greatly enhance the beauty of the park. This tree, though a slow grower, flourishes under dense shade.

South Slope.—This is a two to four-acre field, with a fairly steep southerly slope towards the public road and the stream mentioned above. A few large trees, mostly black and scarlet oaks, occupy the upper part of the slope. This field has been used for a pasture or rather an exercise ground for the dairy herd, and the soil is badly

packed and eroded by the tramping of the cattle. Partly in consequence of this and partly because of their age and over-maturity the trees here are in a very bad condition. Several have died lately, and several more seem to be dying. There is little that can be done to save such old trees. By excluding stock and getting a cover of turf, or by mulching with leaves or straw under the trees, conditions would be improved and the trees would probably respond to some extent, but only a few of the trees seem healthy enough to justify any great effort to save them. Young trees should be planted so as to be ready to take the place of the old trees when they die. It is probable that the sites for the next new buildings will be on this area, so that definite recommendations for planting can not be outlined till the locations of these buildings are decided on. In general, scarlet oak, Spanish oak, shagbark hickory, white oak, black oak and yellow poplar could be planted on the slope, while cow oak, willow oak, river birch and sycamore would be very suitable for planting near the stream. Carolina poplar grows very rapidly and makes a handsome shade tree in moist situations, but on account of its catkins should not be put too near the buildings. Some sycamores planted on the north side of this lot seem to have suffered seriously from sun and cold, or some other trouble, and several have had to be cut down. It is suggested that possibly a tree planted at a distance of ten or twelve feet to the southeast of each of these sycamores, thus warding off the morning sun from the trunk, might prevent further loss. Some shade enduring species, such as sugar maple, Norway spruce or loblolly pine, would be the best. A couple of boards fastened so as to keep the morning sun off the lower part of the trunk might answer the purpose till the trees have grown large enough for protection.

Back Square.—This is the terraced garden at the back of the building. The object here should be to have plenty of grass as well as shade. Trees seem to have been planted here without any thought as to the æsthetic effect. Provision should be made for wide spacing, as a turf can not be maintained under a dense shade. If any extensive improvement of this and the front square is contemplated, it is recommended that the advice of an experienced landscape architect be procured.

The following suggestions on thinning, pruning, planting and the custom of planting class trees apply to the area as a whole and not to any particular part, unless so stated.

Thinning.—The object of thinning is first of all to give to the trees that are left a better chance to grow and develop, secondly, by removing old, dying, suppressed or otherwise undesirable trees, to make room for young, thrifty and more desirable trees to take their place; and, thirdly, though in this case it is of very minor importance, to use up as firewood or other products material that might otherwise go to waste.

On the slope a few trees were marked for immediate removal, because they were extremely poor specimens, and because the surrounding trees and the general appearance of the woodland will be thereby greatly improved. Beside those trees marked there are several of the small red cedars that might be taken out with advantage; but the comparatively few large, old cedars should be left.

Pruning.—Little pruning is required for the general health of the trees. Forest trees do not require pruning in the same way that fruit trees do. Dead branches should be cut out when they are a menace to the people passing underneath; and all dead limbs, where they are much in evidence, may be cut out to improve the appearance of the trees. It may become necessary to remove some live branches in order to open up the woods to make it more park-like and suitable for a promenade. If so, it should be done with judgment, not taking too many branches from one tree. Pruning of live branches should only be done in the winter when the leaves are off.

Planting.—It is recommended to plant trees on this area, both to fill in ground that is not now occupied by trees and also to furnish young specimens that will be ready to take the place of old and deteriorating trees that may soon have to be removed. Good large trees should be used so that as much time as possible will be gained on the age of the tree, and so that it will almost at once become shade producing and ornamental. Trees from six to ten feet high are recommended. Nursery grown trees should be used, both because they are much more easily transplanted and grow off better, and because they are usually a better shape and in better condition than trees procured from the near-by forest.

Detailed instructions for planting and pruning, as well as notes on species of trees desirable for planting in this State, can be found in Bulletin 16 of the North Carolina Geological and Economic Survey, "Shade Trees for North Carolina."

In general, for the best health of forest trees, soil and shade conditions must be kept as nearly like the ideal forest conditions as possible. Leaves should be left on the ground where this is practicable, but where a turf is desired the leaves have to be raked up. When this is necessary the trees will suffer much less if they are close enough together to pretty well shade the ground for the greater part of the day.

Planting Class Trees.—The planting of a class tree is a most desirable and beautiful custom which should have the thorough sympathy and support of the management of the college. This is, however, unfortunately evidence of a lack of forethought and judgment in some cases, in the selection of the kind of tree and the position in which it has been planted. A few suggestions, therefore, to the present and future classes, may not be out of place in this report.

In the first place it would seem advisable for the class, through a committee, to consult with the president, or some one of the faculty appointed by him, as to what is the best species and the most suitable location to plant, in order that some definite and continuous plan for beautifying the grounds may be carried out from year to year. It might also be as well to get the opinion of the man who is in charge of the grounds and who will have the actual work of planting and the subsequent care of the tree.

In choosing the tree consideration must be given, first of all, to the kind of place in which it has to grow. If it is to be planted in an open place, thirty to fifty feet from other trees, a light-demanding species may be used, such as tulip poplar, white or willow oak. If a crowded or rather shady place is selected a shade-enduring species, such as sugar maple, beech or American linden, should be chosen. On dry south slopes scarlet and black oak do well; while red oak, yellow poplar and black walnut want a fairly rich, moist location. For open lawn or park planting the deodar, ginkgo, sweet gum and walnut are effective trees, but they do not show to advantage in a close stand. Again, early-maturing species, such as soft maples and poplars (which does not include the yellow poplar), are not desirable, for, though they grow up very rapidly, they begin to decay early, and after the first fifteen or twenty years they make scraggy, unsightly trees. Most of our larger native forest trees are long lived and continue to improve in health and appearance, if given proper care, up to 100, 150 or even 200 or 300 years old.

In choosing the place to plant the tree as much room should be allowed as possible. No tree that attains to a large size should be closer than thirty to forty feet to those around it. The more room a tree has the larger and more spreading a crown it will develop, though the stem will probably be shorter than if somewhat crowded.

It seems to be the present custom to plant the class tree about commencement time. This is unfortunate. The proper and most successful time to plant trees is before the buds start to unfold in the spring. If planted at this time they usually are little the worse for being moved, and go right to growing. If, on the other hand, they are planted late in the spring or early summer, they quite often do not live; and even when they do, they are apt to be stunted and unhealthy looking. It is suggested that the class tree be planted at Easter, or even earlier than that. The class exercises might then be held at the same time, or be held, as now, at commencement, round the tree that has previously been planted and is at that time starting to grow.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst, N. C.

Two general methods are employed in the regeneration of forest areas, that is, *sowing,* or sowing the seed where the trees are wanted to grow, and *planting,* or sowing the seed in beds and later transplanting them to the areas to be reforested.

Sowing.—It is recommended that two different methods of sowing be tried on this tract: (1) broadcast sowing and (2) sowing in spots.

The preparation of the area to be sown would be the same in both cases, and should be more or less thorough, according to the size of the area and the amount that it was thought desirable to spread on it. The first thing is to insure fire protection, especially for the first few years of the life of the seedlings. This seems pretty well assured at Pinehurst on certain areas adjoining the golf links. But in order to make it even more protected from fire, and at the same time to prepare as suitable a seed bed as possible, the area should, if there is little or no small natural reproduction of pine on the land, be carefully burnt off. If there is a partial stand of pine seedlings

it would be better not to burn. If there is a lot of scrub oak on the area, and there is time before sowing for the green wood to dry out, it might pay to cut the oak to the ground, and when it is dried burn it and the grass together, thus giving the pine seeds a better chance against the shade of the oaks.

(1) Broadcast sowing can be done by hand or with an ordinary broadcast seed sower. The whole area can be sown evenly, or in case of oak brush, the more open areas can be sown and the dense oak patches left. This latter plan is advisable at Pinehurst, as, owing to the large number of quail, the seed will have to be covered, and this can not well be done where the oak is dense. The seed can be covered with a harrow of some sort. Two or three pounds of seed to the acre should be sufficient. The per cent of germination of long-leaf pine seeds is comparatively low, being 50 to 70 per cent, and the seeds are large, so that this would probably give one to two young seedlings per square yard, which would be enough. If an old field is to be sown, a cutaway harrow or brush, or better still, a roller to cover the seed, would put the area in fine condition.

(2) Seeding in spots will probably be the best method on rough land and on areas that have much scrub oak on them. This consists in preparing small spots a foot or two in diameter every six or eight feet each way, and sowing a few seed in each of these. Spots can be omitted or shifted one way or the other in order to avoid any unfavorable place for the growth of the seedlings.

To sow seeds in this way to the best advantage, one man or crew of men should, after burning off, go ahead with mattocks or grubbing hoes and make the spots. They should line up about six or eight feet apart and then make a spot every two or three steps all across the area, keeping equal distances apart. The soil should be loosened up a foot in diameter and three to six inches deep. The men with the seed come on close behind, scatter six to eight seeds on the spot, press them in a quarter to half an inch with the point of the finger, and with one sweep of the hand cover them up. This method can be used where there is some natural reproduction already on the ground, by leaving out the preparatory burning and omitting spots where the seedlings are already dense enough. If the weather is dry, especially in the spring, pressing each spot with the foot, as soon as sown, will assist the germination of the seed.

PLANTING.

Seed Beds.—Sowing the seed in beds where the seed and seedlings can be protected from birds, and from heavy frost or excessive sunshine is generally recommended for species that are easily transplanted. Longleaf pine, however, develops a long taproot very early in its existence, which makes it difficult to transplant, so that where conditions are favorable for sowing, this method of regeneration would probably be preferred. But where the destruction of seed and young seedlings from partridges and other birds is as serious as it is around Pinehurst, planting may be the most practical method, and be the cheapest in the long run.

Seed beds should be made near the house or barn, or in the case of Pinehurst, near the greenhouses, so that they may have constant oversight and can be attended to at odd times, thus making the cost of growing the plants comparatively small. A well-drained, sandy loam soil should be chosen. Beds should be from four to five feet wide to facilitate weeding, and as long as convenient. They should be slightly raised above the surrounding walk to insure thorough drainage. Longleaf pine seed should be sown in rows across the bed from six to ten inches apart, to allow for hoeing; they should be spaced in the row to allow on an average fifteen to twenty seeds to the linear foot. The seed should be covered from one-fourth to one-half inch deep and the surface should then be firmed with a light roller, or by standing on a six-inch board the length of the row, or by gently beating with the back of a spade.

Seeding may be done in the fall or in the spring, it is not known which would be better for the locality of Pinehurst. Only experiment can determine this.

If seeding is done in the fall the seedlings may be transplanted the next spring, before the taproot is too long. This is now being advocated by the United States Forest Service. Perhaps equally good results, or even better, may be obtained by seeding in the spring and transplanting the following fall. By keeping the seedlings in the seed beds longer than this, a stronger and more vigorous root system would be developed, which would greatly assist the plant in starting in its new location, if it can be moved without serious injury. Cutting the taproot three to six inches below the ground with a sharp spade, from six to twelve months before transplanting, in order to induce a growth of lateral roots, has been tried with some success.

Transplanting.—The greatest care should be taken in transplanting to prevent the drying out of the roots of the seedlings. As soon as they are lifted from the bed, care being taken in this operation to break as few roots as possible; the roots should be thoroughly puddled. This is done by having a liquid mixture of clay, cow dung and water in a tub close to the seed beds, which must be kept stirred, and into which the roots of the seedlings are dipped as soon as they are taken from the bed. They are then laid in the box, basket or other receptacle and covered with a wet sack or blanket till they are planted, which should be as soon as possible after lifting.

The area to be reforested should be prepared by burning off the grass and weeds, if there is no natural reproduction on the ground. If some young pines are already there, this should not be done.

The procedure in planting is very similar to that for sowing in seed spots. Two men should work together. The first one crosses and recrosses the area in straight lines, at distances of six to eight feet apart. At every two or three teps he stops and digs a small hole with a mattock, at the same time loosening up the soil a little around it. The second man comes close behind him, before the soil has time to dry out at all, and plants the seedling from the can or box which he carries. The roots should be put as deep as they originally were, and well spread out, the earth pressed firmly around them with the hand, and if the weather is dry, with the foot as well. If the plants are well puddled and the ground fairly moist, no water need be put around the plant; in fact, it would be inadvisable, as it would tend to wash off the coating of clay, put on in puddling, from the roots.

J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

Young trees are very susceptible to fire, and many of them, such as the pines, are destroyed in large quantities by stock and hogs, when these are allowed to run at large. Thus, if good results are to be obtained in reforestation, it is absolutely necessary that the planted areas be protected from fire and stock. This is just as true when applied to forests that are reproducing themselves, because the young trees must have a chance to grow, for unless there is young growth and abundance of it there can be no trees to take the place of the old ones when they are cut. For instance, in a pine forest, if there

are 200 mature pines on an acre, there should be, if the same area were in young trees, 3 to 5 years old, 5,000 or more trees. Not one-twentieth of the young trees that start to grow can be expected to become large trees. They are, however, of valuable service in shading the ground and keeping it moist so that the trees may not suffer with drought in dry seasons; in protecting very young seedlings which will be beneath them from excessive heat; and in forcing those trees which do survive to clear their stems by rapidly pushing their tops upward to get to the light, leaving behind on the stems only a few small limbs, which soon die and drop off, leaving no knots or knot holes.

The need of fire protection has already been thoroughly discussed, but, as protection from stock is also necessary in conserving and protecting our forest areas, it seems advisable to call particular attention to the State of North Carolina of a State-wide stock law.

In New Hanover County there is an abundance of longleaf pine reproduction which has taken place since the stock law went into effect in that county, and the same beneficial results could be obtained in adjoining counties if they also had the benefit of a stock law. It is true in every county of North Carolina that a stock law will do a great deal toward the reforestation of forest lands.

Practically all the more industrious and better class of farmers recognize that the range is of little or no use to them. Most of them feed not only their cattle, but also their hogs on their own land, knowing that they can raise a better grade of stock in the long run at a cheaper price than by allowing it to run at large. So these progressive farmers have the double burden of fencing their crops against their neighbor's stock and of fencing their own stock in. Again, should these progressive farmers attempt to improve their stock by the introduction of better bred animals, the outside cattle will bring the tick, and the hogs will carry the cholera, and these imported animals will be carried off by disease. In this way the open range is a very serious handicap to agricultural progress.

But the great argument against the stock law is that it is hard on the poor man, the man who owns no land. It is he and the small farmer who has hardly begun to realize that any change in conditions have taken place in the last twenty-five years, and is still attempting to make the greater part of his living on the remaining scattered timber, that object most strenuously to the stock law. And yet these are the very men that it would help the most.

The poor man is the first to share in the increased prosperity of a community. He gets better roads, better schools, better stores and higher wages. He can get improved stock, without the annual loss from devastating diseases. His pastures will be better, though he may have to rent them from a neighbor, and his loss of time from hunting stock will be prevented.

And what is the value of this "range" that would be lost? The Forester of the Survey was told that there was hardly a cow in the open range part of Columbus County that is not fed night and morning; evidently there is not enough feed in the range to enable a cow to produce milk. A small farmer in this county, who is bitterly opposed to the stock law as a hardship on the poor man, pointed with pride to a garden of collards, and told the Forester that he had made all his meat off that garden the past year. He had put up the little pigs in the spring and raised and fattened them entirely from that garden. And yet he did not realize how little benefit the range was to him. All his land, except the small area that is fenced and under cultivation, is in woods, and yet, owing to fire and hogs, there is little young growth on it, so that when the present scattered stand of old timber has been removed, this land, on which he is paying the greater part of his tax, will be producing little or nothing. By feeding his hogs on the cleared part of his farm and compelling his neighbors to keep their hogs off his woodland, this forest area can be made a most productive and profitable part of his farm.

Unfortunately the evil effects of the old practice of letting the stock run at large are not confined to the woodlands of the eastern parts of North Carolina. Over a portion of many of our mountain counties cattle and hogs still roam at will. Hogs do less serious injury to the hardwood forests than to the pine, because the former, in many instances, are not absolutely dependent on seed for reproduction, many of our important tree species growing from sprouts. The direct injury to these woods from cattle is confined to certain species, linn and yellow poplar reproductions being especially subject to attack.

The chief injury to our forests from cattle, however, is an indirect one, not only in the mountains, but wherever the stock law is not in force. Every year fires are set out and thousands of acres are burnt over in practically every county in which the cattle still run at large, the reason given being that "it improves the range." There is no

more widespread or fallacious argument advanced as an excuse for burning the woods than this. And the only basis for it is that the young herbage, having no old growth to cover it, is available for the stock somewhat earlier in the spring if the ground is burnt over in the winter. The total effect of burning the range is very harmful, not only to the woods, but to the range itself. The soils get poorer and poorer year by year by the destruction of all vegetable matter, while the better quality of forage plants are seriously injured or killed out by the fire. The quantity of the poorer kinds of grass, which make only early spring pasture, may be slightly increased by killing out the young trees and bushes, but the other forage plants, such as the beggar lice and other peas, on which the stock fatten in the fall, are seriously injured or killed out entirely by fire.

The sooner the whole State comes under the operation of the stock law, the better it will be, not only for the State at large, but more especially for those parts that are now without its advantages. The chief thing lacking to make many parts of North Carolina prosperous agricultural regions is the enforcement of the stock law. Only by putting all the land to its highest use, namely, by cultivating thoroughly and raising as much stock and feed as possible on the cleared land, and by keeping the woodland in the best possible condition by excluding fire and stock, can the present and future prosperity of a community or a State be assured. If it is impossible to bring the whole State under a stock law, there should be a law passed which would make it obligatory on those counties which do not wish a stock law to fence themselves from the counties that accept the stock law. Thus the counties which wish the open range would be compelled to build a fence entirely around the county, and also be compelled to keep up these fences.

The State Geological Survey is still co-operating with the State Board of Education in the examination and disposal of the swamp lands that belong to this Board. The Forester has made several examinations of various tracts and reported the results to the Superintendent of Public Instruction.

In order to bring before the small timber owners the importance of protecting forests from fire and of improved methods of management, the Forester has attended many of the farmers' institutes that have been held under the auspices of the State Department of Agriculture in the western part of the State, and discussed those problems.

The Forester also delivered two lectures at the request of the Professor of Agriculture at the A. and M. College. These lectures were on "Forest Protection," and "Forest Utilization."

*MAGNETIC SURVEY

An act was passed March 7, 1899, regulating the use of and protection of meridian monuments and standards of measure at the several county seats of North Carolina, and on account of the need of the general enforcement of this law in connection with the survey of lands of North Carolina this law is quoted in full below:

AN ACT REGULATING THE USE OF AND FOR THE PROTECTION OF MERIDIAN MONUMENTS AND STANDARDS OF MEASURE AT THE SEVERAL COUNTY SEATS IN NORTH CAROLINA—MARCH 7, 1899.

Whereas, meridian monuments for determining the variations of the magnetic needle of the compass from the true north and a standard length for measuring surveyor's chains have already been established in nearly one-half of the counties of the State by the North Carolina Geological Survey and the United States Coast and Geodetic Survey, co-operating with the Commissioners in the several counties, and similar provision has been made for establishing such standards at the remaining county seats of the State during the present year; and whereas, it is of great importance in the making of all surveys of boundaries of land, townships, counties, etc., that the chains, compasses, and other instruments used by surveyors should at intervals be properly tested,

The General Assembly of North Carolina do enact:

Section 1. That every surveyor operating in any of the counties of this State with magnetic instruments, whether in a public or private capacity, shall, between the first day of January and the thirty-first day of December in each and every year, carefully test his needle upon the official meridian monuments in the county in which he resides, or the nearest county in which such monuments have been erected, by adjusting his instrument over the intersection of the lines cut into the top of one of the meridian monuments so established and sighting to the intersection of the lines cut into the top of the other meridian monument, noting the variation of the magnetic from the

*Appendix 9, Report for 1898-99 U. S. Coast and Geodetic Survey.

true meridian and the direction thereof, and shall test the chain or other instrument of linear measure upon the distance from center to center, as indicated by intersecting lines of the two brass tablets or other official monuments set at or near the county court-house for this purpose, noting the error of such instrument as compared with the standard of the monuments. Such tests and the corrections, if any resulting therefrom, shall be returned by the surveyor in writing and under oath to the Register of Deeds for the county in which such meridian is situate within ten days from the taking of the observations aforesaid, setting forth the name of the surveyor, his residence, the character of the instrument tested, the date of the observations, the declination east or west of the magnetic needle from the true meridian, together with a fee of ten cents for filing and recording the same; and such return shall be filed and recorded by the Register of Deeds in a book properly ruled and lettered, to be furnished by the Board of Commissioners of the county, to be used for such purpose exclusively, and entitled "The Meridian Record": *Provided,* That before making surveys in any county other than the one in which the magnetic instruments for linear measure to be used have already been tested, said surveyor shall procure in writing from the Register of Deeds of the county in which said monuments have been established, nearest to the point where the survey is to be made, a statement giving the declination of the magnetic needle for the year in which it was last determined and the rate and direction of variation of said magnetic needle since that time, and this data shall be recorded as a part of the record of his survey: *Provided, further,* That no surveyor shall be required to go outside of the county in which he resides for the purpose of testing the instruments herein named.

Sec. 2. That it shall be the duty of the Board of County Commissioners to maintain and protect such meridian monuments and tablets or monuments for the testing of chains or other instruments of linear measure, established by the State National surveys, cooperating with the county authorities, in good order and condition as the official standards of the county.

Sec. 3. Any person or persons who shall in any manner injure, deface, remove, or destroy such monuments or tablets, or any part thereof, or who shall fail, neglect, or refuse to do and perform any act, matter, or thing by this act required of him or them to be done,

shall be guilty of a misdemeanor, and upon conviction thereof shall pay a fine or be imprisoned, or both, at the discretion of the court, for every such offense.

Sec. 4. That this act shall be in force from and after its ratification.

There has been established at every county seat in North Carolina stations which mark the true north and south lines. This work was done by the United States Coast and Geodetic Survey in co-operation with the North Carolina Geological Survey.

"There are but few places on the earth's surface where the magnetic needle points true north, and the magnetic declination or variation of compass may be defined as the 'angle between the true north and south line and the magnetic north and south line as pointed out by a compass needle, *i. e.*, a magnetized needle so mounted as to swing freely about a vertical axis.' "

The stations which have been established in each county and for the most part at the county seat are marked with solid granite posts weighing about four hundred pounds each. The top of the monument is dressed about six inches square and is lettered

N. C. G. S.

+

U. S. C. S.

The center of the cross marks the precise point. These granite posts are about four and a half feet long, four feet of which is left in the rough and is sunk into the ground; the rest of the stone is dressed and projects six inches out of the ground. These granite monuments are used to mark the north and south ends of the true meridian lines established in connection with the magnetic survey.

In order to assist surveyors in making use of the county meridian lines, either for determining the magnetic declination or for ascertaining the index errors of their instruments, the following directions are given:*

"If the instrument used be mounted on a tripod, it should be carefully centered and leveled over the cross on top of the same monument—the 'reference' monument—over which observations were

*Appendix 9, Report for 1898-99—U. S. Coast and Geodetic Survey p. 923.

made in the magnetic survey and described in the descriptions of stations as published in this report. The monument to be sighted on is termed the 'range' monument.

"Should the instrument used be mounted on a simple Jacob's staff, it can be placed in the meridian line as close to the 'reference' monument as possible and leveled.

"A small rod should then be held in a vertical position over the cross in the top of the other monument—the 'range' monument. The compass needle is released and magnetic bearing of the small rod read. This should be done with a small nonmagnetic magnifying glass, and it should be repeated about ten times, disturbing the needle with a bit of iron and letting it come to rest before each reading. The mean of all these bearings should be taken as the magnetic declination west or east, as the case may be.

"In order to obtain the mean declination for the day (24 hours) these results should be obtained between 10 and 10:30 a. m., or about 6 p. m. local mean time. The local mean time is obtained by subtracting from the railroad time four minutes for every degree of longitude the surveyor is west of the seventy-fifth meridian of longitude. No observations should be made during times of violent changes of the pointing of the magnetic needle, as *e. g.*, during magnetic storms.

"Should the resulting declination differ essentially from the declination as obtained from the published value in this report, it proves conclusively that the surveyor's instrument has an error, which should be gotten rid of as nearly as possible by putting the instrument and needle in good adjustment. Any difference still remaining after the surveyor has satisfied himself that his instrument is in first-class condition and in good adjustment should be duly allowed for and recorded by the surveyor.

"According to the Act of March 7, 1899, a copy of which is given above, all results for declination taken over any of these monuments should be entered in the book kept by the Register of Deeds, giving the year, the day, and the local time the observations were made, and should also be entered on surveys made at that time."

The surveyor is referred to the report of the Coast and Geodetic Survey, mentioned above, for tables showing the declination at the various county seats in North Carolina for different areas. These reports can be obtained from the United States Coast and Geodetic

Survey, Washington, D. C., or the North Carolina Geological and Economic Survey, Chapel Hill, N. C.

Magnetic declination at the various county seats in North Carolina, January 1, 1910, as determined by the United States Coast and Geodetic Survey are as follows:

MAGNETIC DECLINATION AT THE COUNTY SEATS, JANUARY 1, 1910.

County.	Town.	Magnetic Declination.		
		°	′	
Alamance	Graham	2	25	West
Alexander	Taylorsville	1	05	West
Alleghany	Sparta	1	22	West
Anson	Wadesboro	0	21	West
Ashe	Jefferson	1	10	West
Beaufort	Washington	3	08	West
Bertie	Windsor	4	54	West
Bladen	Elizabethtown	2	00	West
Brunswick	Southport	2	16	West
Buncombe	Asheville	0	18	West
Burke	Morganton	0	47	West
Cabarrus	Concord	3	13	West
Caldwell	Lenoir	1	00	West
Camden	Camden	4	30	West
Carteret	Beaufort	3	02	West
Caswell	Yanceyville	2	21	West
Catawba	Newton	1	03	West
Chatham	Pittsboro	2	58	West
Cherokee	Murphy	1	47	East
Chowan	Edenton	3	53	West
Clay	Hayesville	1	33	East
Cleveland	She by	0	32	West
Columbus	Whiteville	2	06	West
Craven	New Bern	3	11	West
Cumberland	Fayetteville	2	05	West
Currituck	Currituck	5	10	West
Dare	Manteo	4	46	West
Davidson	Lexington	1	33	West
Davie	Mocksville	1	23	West
Duplin	Kenansville	1	58	West
Durham	Durham	1	46	West
Edgecombe	Tarboro	3	55	West
Forsyth	Winston-Salem	2	07	West
Franklin	Louisburg	2	46	West
Gaston	Dallas	0	55	West
Gates	Gatesville	4	07	West
Graham	Robbinsville	0	58	East
Granville	Oxford	2	27	West
Greene	Snow Hill	3	47	West
Guilford	Greensboro	1	14	West
Halifax	Halifax	2	22	West
Harnett	Lillington	2	22	West
Haywood	Waynesville	0	28	East
Henderson	Hendersonville	0	14	West
Hertford	Winton	3	38	West
Hyde	Swan Quarter	3	43	West
Iredell	Statesville	1	14	West
Jackson	Webster	1	12	East

MAGNETIC DECLINATION AT COUNTY SEATS, JANUARY 1, 1910.—Continued.

County.	Town.	Magnetic Declination.		
		°	′	
Johnston	Smithfield	1	20	West
Jones	Trenton	2	40	West
Lee				
Lenoir	Kinston	2	12	West
Lincoln	Lincolnton	1	02	West
McDowell	Marion	1	23	West
Macon	Franklin	1	05	East
Madison	Marshall	0	17	West
Martin	Williamston	3	25	West
Mecklenburg	Charlotte	0	48	West
Mitchell	Bakersville	0	35	West
Montgomery	Troy	1	50	West
Moore	Carthage	1	40	West
Nash	Nashville	2	04	West
New Hanover	Wilmington	2	14	West
Northampton	Jackson	3	33	West
Onslow	Jacksonville	2	53	West
Orange	Hillsboro	2	31	West
Orange	Chapel Hill	1	56	West
Pamlico	Bayboro	3	07	West
Pasquotank	Elizabeth City	4	39	West
Pender	Burgaw	1	50	West
Perquimans	Hertford	3	37	West
Person	Roxboro	2	38	West
Pitt	Greenville	2	57	West
Polk	Columbus	0	27	West
Randolph	Asheboro	2	22	West
Richmond	Rockingham	1	48	West
Robeson	Lumberton	1	34	West
Rockingham	Wentworth	2	21	West
Rowan	Salisbury	1	06	West
Rutherford	Rutherfordton	0	42	West
Sampson	Clinton	1	57	West
Scotland	Laurinburg	1	43	West
Stanly	Albemarle	1	23	West
Stokes	Danbury	1	48	West
Surry	Mount Airy	1	37	West
Swain	Bryson City	0	24	East
Transylvania	Brevard	0	03	West
Tyrrell	Columbia	4	23	West
Union	Monroe	0	40	West
Vance	Henderson	2	54	West
Wake	Raleigh	2	51	West
Warren	Warrenton	2	52	West
Washington	Plymouth	3	51	West
Watauga	Boone	0	55	West
Wayne	Goldsboro	2	12	West
Wilkes	Wilkesboro	0	56	West
Wilson	Wilson	2	21	West
Yadkin	Yadkinville	1	27	West
Yancey	Burnsville	0	30	West

During the past two years one station was reoccupied and two new stations established.* The station at Fayetteville, Cumberland

*Report of the U. S. Coast and Geodetic Survey for 1909, pp. 131, 132.

County, established in 1899, was reoccupied. The south monument of the meridian line is in a lot owned by the city near the old court-house square, in front of Mr. Underwood's house. The north monument is in the court-house square. The following true bearings were determined in 1909:

South meridian stone (mark)	00°	01.0′	west of south.
Lower western inside edge of central arch at base of the old market house	17	00.9	west of south.

The station at Beaufort, Carteret County, established in 1898, being no longer suitable for magnetic work, a new station was located in the northwest corner of the court-house ground to the westward of the north monument of the 1898 meridian line. As a new court-house had been erected on this meridian line, the north stone was moved to mark the position of the new station. The stone is a granite (rough) post, about 9 inches square and about 3½ feet long, projecting about 14 inches above ground. The top is rounded and has a drill hole to mark the exact point. The station is north 10½° west and distant 194.7 feet from the northwest corner of the west steps of the court-house, 33.8 feet from the center of the sidewalk along the west side of the court-house square, and 77.4 feet from the center of the walk along the north side of the square. The following true bearings were determined:

Methodist Church spire (white) (mark)	0°	29.0′	west of south.
Spire on Methodist Church (colored)	0	53.7	east of south.
Ball on courthouse dome	18	50.5	east of south.
Northwest corner of west steps of courthouse	10	29.1	east of south.

A new station was also established by the Coast and Geodetic Survey at Manteo, Dare County. It is in the southeastern corner of the field immediately surrounding the poor-house, about 1½ miles west of the center of town. It is 42.7 feet northwest of the fence on the southeast boundary of the field, and 99 feet northeast of the fence on the southwest. The station is marked by a granite post 7 by 7 inches, projecting about 15 inches above the ground and lettered N. C. G. S.—U S. C. S., 1898.

The following true bearings were determined:

Southeast corner of poorhouse, just under eaves of roof	47°	47.4′	west of north.

A similar stone was set 200 feet north of the magnetic station to mark the north end of a meridian line.

FISHING INDUSTRIES

Since the establishment of the Fish Commission of North Carolina by the General Assembly of 1907, the State Geologist has been obliged to give considerable time and attention to the work of this Commission, and he has had to approve all accounts and vouchers before warrants would be issued for them by the auditor. The work of the Commission has been very greatly handicapped by the fact that the Commission has jurisdiction only over a portion of the commercial fisheries, as the following counties were exempted from the Fish Commission Bill of 1909: Beaufort, Camden, Carteret, Craven, Currituck, Hyde, Jones, Brunswick, New Hanover, Onslow, Pender and Pamlico.

The protection of the fish and the fostering of the fishing interests of North Carolina are not county questions, but State questions. They are not questions of interest simply to the individual, but to the whole people, and in passing laws to protect and foster our fishing industries we must consider the State before the county and the whole people before the individual. From the investigations made by the State Survey, undoubtedly the only adequate method of enforcing our fish laws and fostering our fishing industries is through a Fish Commission, which will have jurisdiction over all the commercial fisheries in all the counties of the State. A Commission that will not only see that the laws are enforced (and if there is a bad law, its enforcement will very quickly cause it to be repealed, and every law until it is repealed should be enforced), but also be able to render a just decision regarding what is the right thing to do for the best interests of the State, will be able to build up the fishing industries of this State to a point where they will be worth from three to five times what they now are, and enable the State to derive revenue from them.

Nearly all the bills that are introduced at each Legislature relating to fishing in eastern North Carolina are local and the benefits that it is supposed will be derived by their passage are limited, and little thought or consideration is given regarding the hardships or injustice that the passage of such bills would work on other sections of the same county or other counties. The General Assembly of 1909, realizing the great value of the fisheries to the State of North Carolina, and that these fisheries are being rapidly depleted and that some measures are necessary to prevent this depletion and that steps should

be taken to foster and perpetuate them, passed the following resolution:*

Resolved by the House of Representatives, the Senate concurring:

SECTION 1. That there shall be created a committee of seven, three to be appointed by the Speaker of the House from the members of the House of Representatives and two by the President of the Senate from the members of the Senate. Of the three members of the House, one shall be from the western part of the State, one from the central part of the State, and the third from the eastern part. The President of the Senate shall appoint one member from eastern North Carolina and one from the central part of the State. None of the seven members of the committee shall be financially interested in any of the fisheries. The President of the Senate and the Speaker of the House of Representatives shall be members of said committee.

SEC. 2. This committee shall thoroughly investigate the fisheries of North Carolina, including fin fish, oyster, clam and other mollusca, crab, lobster, terrapin, etc., and make a report in the form of a bill, to be presented to the Legislature of one thousand nine hundred and eleven, which will embody such legislation as in their judgment they deem best for the building up of the fisheries of North Carolina.

SEC. 3. In order to facilitate the work of this committee, they are hereby authorized to request the Commissioner of the United States Bureau of Fisheries to detail one of their experts to sit with the committee during its deliberations. The committee is further authorized to visit and examine any portion of the waters of North Carolina which they deem necessary in order to fully inform themselves upon the existing conditions relating to the fishery industries. This committee is also further authorized to use the State boat under the control of the Oyster Commissioner in going from one part of the rivers and sounds of eastern North Carolina to another. The committee is also further authorized to call in for consultation the Fish Commissioner, the Oyster Commissioner, the State Geologist and other public servants that they believe can give them any information of value regarding the fishery industries. They are further authorized to sit at some central point in eastern North Carolina, after they have visited what places they deem necessary for the collecting of information, where delegations of fishermen or representatives of fishermen from various portions of eastern North Carolina can appear before the committee to give information regarding the fisheries of the State.

SEC. 4. The committee shall be allowed all their actual expenses in attending to this work and four dollars per diem while in the actual performance of their duties, but the per diem shall not be for more than thirty days.

SEC. 5. This act shall be in force from and after its ratification. Ratified this 4th day of March, A. D. 1909.

The State Geologist was requested by the Lieutenant-Governor, who was Chairman of the Legislative Fish Committee, to arrange the itinerary of the trip of inspection of the fisheries of North Carolina, and he has attended all the meetings of this committee and assisted

*Public Laws of 1909, p. 1352.

them in every way possible in drafting their report to be presented to the General Assembly of 1911. The work of this committee has been very thorough, and they were very ably assisted in their work by Dr. H. F. Moore, of the United States Bureau of Fisheries, who was detailed by Hon. George M. Bowers, Commissioner, to sit with the committee as one of its members. The report of this committee, which will be made to the General Assembly in the form of a bill, should be given most careful consideration, and its passage will undoubtedly be the means of building up the value of the fisheries of the State.

The Geological Survey and the Fish Commission have received the most cordial co-operation from the Bureau of Fisheries in connection with their work, and in the propagation of fish the United States Fish Commission have very generously co-operated with the Commissioner in those counties that are under his jurisdiction. In the counties, however, that are exempted from the jurisdiction of the Fish Commission, the United States Bureau of Fisheries have refused to consider the planting of fish-fry in any of the rivers or streams of these counties.

In an application from Craven County for shad fry to be planted in Trent and Neuse rivers, the United States Bureau of Fisheries state their position as follows:

"The position of the Bureau in this matter is that laws for the protection of shad should be enforced by the authority of the State and not be left to local communities. Under the terms of the existing legislation, the Albemarle Sound region is the only place in North Carolina where these conditions are properly met. In consequence thereof shad are afforded an opportunity to reach tributary waters and fish cultural operations are carried on greatly to the benefit of the industry. The propriety of the Bureau's stand in this matter seems unquestionably attested by the increase and take of shad eggs at the Edenton station from less than seven millions in 1905 to seventy millions in 1910.

"At such time as there is an extension of the general law to other waters of the State, the Bureau will gladly undertake to amplify its shad operations now confined to the Albemarle Sound region."

In connection with the general condition of the fishing industries in North Carolina, Hon. George M. Bowers, Commissioner of the

United States Bureau of Fisheries, in reply to a request from the State Geologist for certain information, stated as follows:

"In reply to your inquiry you are informed that this Bureau can not furnish you in the form or detail which you desire, a comparison between the fisheries of North Carolina five years ago and at the present time. The Bureau has made no statistical canvass of the State since 1902, and the recent inquiry, conducted by the Bureau of the Census was on a different basis and such information as it furnishes applies to the State as a whole and is incapable of analysis in respect to the several counties.

"The Bureau has prepared from the data available the appended Table I, making a comparison of the catch of the important species of fishes in the years 1902 and 1908, respectively. As the condition of the fisheries in respect to the necessity of regulation is indicated by the quantity caught rather than by the value of the catch, the comparison is based on the former factor, though the value of the product of each species in the year 1908 is shown to exhibit their comparative commercial importance.

TABLE I.

Species.	1902. Quantity pounds.	1908. Quantity pounds.	Value.	Quantity, decrease per cent.
Alewives	11,172,975	10,927,000	$140,380	2.2
Blackbass	632,675	511,300	39,610	17.3
Bluefish	977,142	1,256,500	45,170	*22.2
Butterfish	83,218	1,302,000	28,990	*1469.0
Croakers	1,928,635	1,177,100	31,190	39.0
Flounders	261,762	402,900	16,390	*54.0
Hickory Shad	684,896	377,000	20,230	45.0
Kingfish or Whiting	120,480	816,600	27,710	*580.0
Menhaden	18,862,000	57,412,300	70,330	*204.0
Mullet	6,705,492	5,070,500	174,760	21.0
Perch (white and yellow)	1,047,042	1,353,300	58,270	*29.0
Shad	6,566,724	3,942,300	372 920	40.0
Spanish Mackerel	354,084	457,300	34.210	*29.0
Spot	872,695	852,300	15,720	2.0
Squeteague or Trout	3,781,456	4,634,600	206,240	*23.0
Striped Bass	1,175,400	509,700	36,250	111.0
	63,764,984	97,772,300	1,776,020	

*Increase.

"It will be observed that the total catch of fish in 1908 exceeded that of 1902 by over 35,000,000 pounds, or about 65 per cent, though, it may be remarked, the value of the catch was less than 4 per cent greater. The increase in the catch was almost wholly due to the fishery for menhaden, which has annually grown more intense and important for the past ten years, and more than trebled in its product between 1902 and 1908. Considering the food fishes alone, the total catch of the 15 species enumerated has decreased about 5 per cent in quantity and the value has increased about the same percentage. For practical purposes the two may be regarded as on an equality in the two years cited. An analysis of the details of the table shows wide variation in the catch of the individual species, eight exhibiting a decrease and seven an increase in the year 1908.

"The species which show an apparent decrease in abundance are mainly those which were most valuable in 1902. Of those whose value exceeded $50,000 in that year the catch of five decreased and of two increased. Of the less valuable fishes six exhibit an increase and three a decrease in the quantity caught.

"It would appear, therefore, that as the more valuable species, such as the shad, became scarcer, the fishermen put forth greater exertions to take the less valuable fishes, and that many which before were more or less discarded were placed on the market. This is a common phenomenon of a fishery becoming depleted.

"A further analysis shows that of the fishes exhibiting a decrease in 1908 the majority were either anadromous or resident species, that is fishes which are more certainly affected by the local fisheries of North Carolina, while those species which were caught in increased abundance were mainly those ranging widely or which do not habitually return to their native waters. Of the anadromous class we have the alewives, hickory shad, and striped bass, which have decreased, while the white perch has increased. The mullet, which may be called semi-anadromous, has decreased.

"Of the resident species we have two, one of which, the black bass, has decreased, while the flounder has increased very materially in the catch. The latter is one of the fishes more highly regarded than formerly, its price rising from two cents per pound in 1902 to over four cents in 1908, and it is probably true in North Carolina, as in other places, that many are now saved by the fishermen and shipped, when formerly they were thrown away as trash fish.

"Of the strictly pelagic, or widely wandering fish, three species are listed. These are the bluefish, the Spanish mackerel, and the squeteague, the catch of all of which was greater in 1908 than in 1902. Of what may be called semi-wandering species there are four, of which the butter fish and the kingfish or whiting have increased, the croakers have decreased, while the quantity of spots taken has remained nearly stationary. These four species move back and forth between the sea and the sounds without much system.

"From the foregoing it appears reasonable to deduce the conclusion that those fishes have decreased for which there has been a good demand, and which was therefore the objects of an intense fishery, and which at the same time had habits making them especially susceptible to the influence of the local fishery. The fishes of which a greater quantity are now caught are those for which there was formerly an inferior demand and which have more or less wandering habits, not leading them to return to State waters.

"Of the shad, which for years has constituted between 30 and 40 per cent of value of the catch of fishes, excluding the oyster and other shellfishes, the Bureau can speak with confidence. In 1897 there were caught 8,963,488 pounds, valued at $362,811; in 1902, 6,566,724 pounds, worth $384,808; and in 1908, 3,942,300 pounds, yielding the fishermen $372,920. While the value of the catch has remained practically stationary the quantity has decreased 40 per cent since 1902, and 127 per cent since 1897. Between 1897 and 1902 there was an increase of 115 per cent in pound nets, 50 per cent in seines, and a decrease of about 50 per cent in the gill nets in use in the State.

"Between 1901 and 1905 the supply of ripe eggs which the Bureau was able to obtain for its hatchery at Edenton fell from 75,000,000 to 6,748,000. Since 1905 the yield has gradually risen from the low level stated to 59,685,000 in 1909. The average annual yields for three-year periods since 1901 have been as follows:

1901-1903	49,900,000 eggs.
1904-1906	10,889,000 eggs.
1907-1909	46,398,000 eggs.
1909-	59,685,000 eggs.
1910-	69,000,000 eggs.

"The yield for 1909 was higher than for any year since 1901.

"The reason for the decrease in the first two periods and for the increase in the third appears not difficult of determination. The eggs are all obtained at the upper end of Albemarle Sound, and the ripe fish taken there, in their course from the sea to the spawning grounds, must first pass through the narrow confines of the inlets and sounds, where they are especially open to capture. Prior to 1906 there was a great increase in the number of nets of all kinds, and they were fished in such manner that they served as almost complete barriers to the passage of the fish.

"In 1905 a law was passed maintaining an open channel, free from nets of all kinds, from the inlets to the spawning grounds, and in 1906 its effect became apparent by an increase in the number of eggs taken to 25,643,000 from the insignificant take of 6,748,000 in the previous year, and by 1909 the take had again more than doubled.

"The Bureau has no data from which to determine whether the catch of shad in the upper sounds has increased since 1906, but there is little doubt that it has, as stated by the fishermen, and there can be no doubt that a much larger proportion of the fish are propagating both through natural means and the agency of the hatchery.

"These facts furnish the clue to the means by which the fisheries of North Carolina may be fostered and perpetuated. The fish must be given access to their spawning grounds, and the hatchery must be granted every facility for obtaining its supply of eggs. The nets must be restricted as to location and if necessary as to number and size, so as to furnish an avenue of passage for the fish. Furthermore, the laws must be so drawn that while restricting reckless fishing they must not interfere with the capture of fish for the specific purposes of artificial propagation, nor make the cost of obtaining ripe eggs so high as to be prohibitive.

"That these ends may be effectively attained it is obligatory that the administration of the laws be vested in State affairs and not committed to county authority with local prejudices and a limited purview. Local regulation of the fisheries has everywhere proved a complete failure and to experiment with it is to invite disaster to the fisheries committed to its care.

"George M. Bowers,
"Commissioner."

In connection with the enforcement of the laws regulating fishing in North Carolina, it has been found necessary to have the areas properly surveyed and marked in which fishing is restricted or prohibited. The Fish Commissioner and the State Geologist have been very greatly assisted in this work by the United States Coast and Geodetic Survey and the United States Bureau of Fisheries, and without the assistance of these Federal Bureaus it would have been impossible for the Fish Commissioner to have accomplished the work desired. An act authorizing the co-operation of the Federal Bureaus in surveying out these restricted areas in North Carolina was introduced into Congress by Hon. John H. Small, and passed on the 4th day of March, 1909. The following is a copy of this bill:

Section 1. That the Secretary of Commerce and Labor be, and he is hereby, authorized and directed, upon the request of the Governor of the State of North Carolina, to designate such officers, experts, and employees of the Bureau of the Coast and Geodetic Survey and of the Bureau of Fisheries as may be necessary to co-operate with the North Carolina State Fish Commissioner in making a survey of and marking in a prominent manner all those areas of the waters of the sounds and their tributaries of the State in which the use of any or all fishing appliances are prohibited by law; and the Secretary of Commerce and Labor is hereby authorized and directed to furnish to the officers, experts, and employees of said Bureaus so detailed as aforesaid such instruments, appliances, and steam launches as may be necessary to make the survey aforesaid; and the Secretary of Commerce and Labor is hereby authorized to have made in the Bureau of the Coast and Geodetic Survey all the plats necessary to show the results of the aforesaid survey, and to furnish to the Fish Commissioner of the State of North Carolina such copies as may be necessary for his use, and for this purpose to employ in the District of Columbia and elsewhere such technically qualified persons as may be necessary to carry out the purposes of this act.

Sec. 2. That the Secretary of Commerce and Labor is hereby further authorized to have erected or constructed by the officers so detailed as aforesaid, while making said survey, such structures as may be necessary to mark in a prominent manner the points of triangulation so that the same may be used for such future work of the Coast and Geodetic Survey as the said Bureau may be hereinafter required to perform in prosecuting the government coast survey of the navi-

gable waters of the United States located within the State of North Carolina.

Sec. 3. That the Bureau of the Coast and Geodetic Survey and the Bureau of Fisheries be, and they are hereby, authorized and directed to expend, under the direction of the Secretary of Commerce and Labor, such sum or sums of money as may be necessary, and as may be hereinafter appropriated, in carrying out the purposes of this act.

Under the authority of this act the Coast and Geodetic Survey cooperated with the Fish Commission in making a permanent survey of the restricted areas and detailed Mr. G. T. Rude, of that department, to have charge of the work. The Fish Commission agreed to furnish buoys and concrete sinkers in compliance with specifications of the United States Bureau of Fisheries and also to have an available boat suitable for carrying on the work of the survey. This survey was begun on December 15, 1909, and Captain Rude's report of the work accomplished is given below:

REPORT OF THE SURVEY FOR THE NORTH CAROLINA FISH COMMISSION, REFERRING TO DUTCH OR POUND NET FISHING IN ALBEMARLE, CROATAN AND PAMLICO SOUNDS, AND CHOWAN RIVER, N. C.

BY GILBERT T. RUDE,

ASSISTANT CHIEF OF PARTY, COAST AND GEODETIC SURVEY, DECEMBER 15, 1909, TO FEBRUARY 19, 1910.

SIR:—I have the honor to submit the following report of my work in North Carolina, co-operating with the Fish Commissioner of that State, in accordance with your instructions issued December 9, 1909.

This work was done for the purpose of locating buoys for laying off the restricted areas and limiting areas for fishing in accordance with "Acts of the General Assembly of North Carolina, 1909, relating to Fish and Fisheries," a copy of which is submitted with this report.

I left Washington December 13th, and arrived at Manteo, headquarters of the Fish Commission, December 14th. After hiring a crew for the launch, furnished by the Fish Commission, and procuring the necessary implements, stakes, etc., I left Manteo on December 18th for Hatteras Inlet, where the work was started.

December 19th and 20th were stormy and no field work was possible, but on December 21st, the weather having cleared, four stakes

were placed, Nos. 1, 2, 3 and 4, around the restricted area from Hatteras Inlet. On December 22d stake No. 5 was placed, completing the work at Hatteras Inlet, and on the same day I returned to Manteo.

On December 23d work was begun at Roanoke Marshes and the work carried southward toward Long Shoal River. There are eighteen stakes in this area, and owing to bad weather and to the fact that the launch was out of commission for a week on account of broken shaft, the remainder of the month of December and nineteen days of January were consumed in this work.

On January 20th I replaced stake No. 14, which had been moved by unknown parties, and returned to Manteo.

On January 22d work was begun around the south end of Roanoke Island, Oregon Inlet Restricted Area, New Inlet Restricted Area, and the "Ten-mile Limit." It was necessary to have good days for the work on these areas in the middle of the sound, so the bad days were used in measuring bases and placing stakes around the south end of Roanoke Island. This work, together with the stakes on the west side of Coatan Sound, was completed on February 10th.

On February 14th I left Manteo in company with the Fish Commissioner, and proceeded to Edenton by steamer and train and made arrangements for the survey on the Chowan River.

The Fish Commission launch arrived on the night of the 14th, and on the 15th I began the work on the river at Colerain's Wharf. Sixteen stakes were placed in the river from Holiday Island to the mouth of the river, consuming four days, the 15th, 16th, 17th and 18th, and on the 19th I left Edenton for Washington, reporting at the office on the 21st.

The restricted area at Hatteras Inlet, in which no kind of net may be fished, is marked by buoys Nos. 1, 2, 3, 4 and 5, and extends one mile each side of a line six miles long, running from the center of the inlet in a N. $\frac{1}{2}$ W. direction, so as to cover the main channels from the inlet.

There is no fishing of any amount between this area and the "Ten-mile Limit," which is marked by buoys Nos. 24, 25, 26, 27, 28, 29, 30 and 31. Buoy No. 24 is ten statute miles from Roanoke Marshes Light House and on the S. S. E. Reference Line from Big Island, the island known by that name on the Coast and Geodetic Survey charts. Buoys Nos. 27 and 28 are on the S. S. E. Reference

Line and also mark the western end of the restricted area from New Inlet, which is one mile each side of a center line from the center of New Inlet and running in a W. ½ S. direction to the "Ten-mile Limit."

No nets of any kind may be set in this area. Buoy No. 29 is on the S. S. E. Reference Line. Buoy No. 25 is ten statute miles from Roanoke Marshes Lighthouse and ten thousand yards west of the S. S. E. Reference line. Buoys Nos. 26, 30 and 31, together with No. 25, mark the line two thousand yards west of the S. S. E. Reference Line.

Buoys Nos. 32, 33, 34, 35, 36 and 37 mark the restricted area from Oregon Inlet in which no kind of nets may be set. This area is one mile each side of a line from the center of Oregon Inlet and running in a W. S. W. direction two thousand yards beyond the S. S. E. Reference Line.

Buoy No. 39 is one thousand yards from the east point of Hog Island and also on the line between Pamlico and Roanoke Sounds. Buoys Nos. 38, 40, 41 and 42 are one thousand yards from Hog Island and the lines joining these buoys limit the length of pound nets setting from Hog Island to one thousand yards. Buoy No. 48 is on the two and one-half mile radius from the Roanoke Marsh Lighthouse and also one thousand yards from the Roanoke Island shores, limiting the nets setting between the radius buoy (No. 48) and the west buoy (No. 41) of the Hog Island series to one thousand yards. Buoy No. 49 is on the two and one-half mile radius from Roanoke Marsh Lighthouse and five hundred yards from the Roanoke Island shore.

Buoy No. 50 is five hundred yards from the Roanoke Island shore and the line between buoys Nos. 49 and 50 limits to five hundred yards the nets setting from the Roanoke Island shores and within the two and one-half mile radius of Roanoke Marsh Lighthouse.

Buoys Nos. 6, 7 and 8 are five hundred yards from Roanoke Marshes and limits to five hundred yards the nets setting from Roanoke Marshes.

Buoy No. 9 is on the two and one-half mile radius from Roanoke Marsh Lighthouse and two thousand yards off shore. In accordance with a special concession for this district nets are allowed to set out to the straight line joining buoy No. 6 (the south five hundred yards' buoy from Roanoke Marshes) with buoy No. 9.

Buoys Nos. 10, 11, 14, 15, 13, 12, 16, 17, 18, 19, 23, 22, 21 and 20 are given in their order as they extend southward from buoy No. 9 to Long Shoal River. These buoys are two thousand yards off shore and pound nets are allowed to set out to the straight line joining these buoys except in the following cases: Along the shore east of the entrance to Stumpy Point Bay nets are allowed to set out to the line joining buoys Nos. 12 and 13 until they pass to the westward of buoy No. 12, where they are allowed out to the range of the two buoys. This condition holds till passing far enough to the westward to bring buoys Nos. 16 and 17 on range, then this range governs all nets setting out from the Wild Boar Point shore north of buoy No. 16. After passing south of buoy No. 16 the straight line joining buoys Nos. 16 and 17 governs all the nets setting out from the shore between Wild Boar Point and Sandy Point. Nets setting out from the shores between Sandy Point and Long Shoal Point are allowed out to the straight line between buoys Nos. 19 and 23, but after passing to the westward of buoy No. 23 they are allowed out to the range of these buoys, until passing far enough to the westward to bring buoys Nos. 21 and 22 on range, which range governs all nets setting out from Long Shoal Point as far west as buoy No. 22, when they are governed by the straight line between buoys Nos. 22 and 21. After passing west of buoy No. 20 nets are governed by the range of buoys Nos. 21 and 20 till reaching the line limiting jurisdiction of Fish Commissioner, which runs from center of Hatteras Inlet to the center of the entrance of Long Shoal River.

Owing to the fact that few nets are set on the east side of Croatan Sound and in Albemarle Sound these areas were not buoyed, the buoys being used for more important places.

Buoy No. 43 is on the two and one-half mile radius from Roanoke Marsh Lighthouse and off shore one-fifth the width of the sound at that point. Nets are allowed out to the straight line joining buoy No. 8 (the north five hundred yard buoy off Roanoke Marshes) and buoy No. 43. Buoys Nos. 44, 45 and 46 are off shore one-fifth the width of the sound at the points from which they are placed. Buoy No. 47 is in Albemarle Sound and two thousand yards off shore.

Buoys Nos. 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65 and 66 are in the Chowan River from Holliday Island to the mouth of the river. These buoys are placed one-third the width of

the river and pound nets are allowed out to the straight lines joining the buoys along the same side of the river.

The method of locating the boundary and placing the buoys was as follows:

The prescribed areas at Hatteras, New and Oregon Inlets, the "Ten-mile Limit" and the Chowan River were laid off on the projection in accordance with the law as interpreted by the Fish Commissioner and myself and the contemplated position of the buoys pricked on the projection. At each place the launch was maneuvered and placed on the position by sextant angles and a graphic solution of the three-point problem. This method was also used along the shores where it was impossible to measure bases of sufficient length, although in these cases the shore line from which the measurement was to be taken was accurately determined by sextant angles and plotted on the projection.

Where possible a base line parallel with and range at right angles to the point of shore off which the boundary buoy was to be placed at the near end of the base line and on a range pole off shore. The distance from shore being known, and the direction being given by the range, a triangle was presented for solution, which has the two sides with the included angle given and the angle at the far end of the base was computed. The theodolite was then taken to the far end of the base and the computed angle turned off. The boat was then run out to the range, and when it passed the cross hairs of the instrument a weighted target-signal was let run from a pole set alongside the instrument; instantly a flag buoy was dropped from the boat. The boat then rounded up, returned to the flag buoy and placed a stake on the position.

There is also submitted with this report a list of magnetic bearings and courses from the different buoys as scaled from the projection.

My thanks are due Mr. Theodore S. Meekins, Fish Commissioner of North Carolina, for his hearty co-operation and assistance in the work. Capt. O. J. Wescott, pilot, and Dave Collins, hand, should also be mentioned for their cheerful co-operation and willingness to perform their duties. Respectfully submitted,

(Signed) Gilbert T. Rude,

Assistant C. and G. Survey, Chief of Party.

To the Supt., Coast and Geodetic Survey, Washington, D. C.

MAGNETIC COURSES AND BEARINGS FROM THE BUOYS.

Buoy No. 1.

Course to Buoy No. 2.....N. ½W.
Course to Buoy No. 5.....West.
Hatteras Inlet Lighthouse bears.....N.N.W. ½W.
Hatteras Inlet L.S.S. bears.....S.W. x S.
Egg Shoal bears.....S.E. x E.

Buoy No. 2.

Course to Buoy No. 1.....S. ½E.
Course to Buoy No. 3.....N. ½W.
Hatteras Inlet Lighthouse bears.....N.W. x W.
Hatteras Inlet L.S.S. bears.....S.S.W.
North Methodist Church bears.....S.E. ¾S.
Egg Shoal bears.....E. ½N.

Buoy No. 3.

Course to Buoy No. 1.....S. ½E.
Course to Buoy No. 4.....W. ½S.
Hatteras Inlet Lighthouse bears.....S.W. ½S.
Egg Shoal bears.....S.E.

Buoy No. 4.

Course to Buoy No. 3.....E. ½N.
Course to Buoy No. 5.....S. ½E.
Hatteras Inlet Lighthouse (Light) bears.....S.E. ¼E.
Hatteras Inlet L.S.S. bears.....South.

Buoy No. 5.

Course to Buoy No. 4.....N. ½W.
Course to Buoy No. 1.....N. x E. ¾E.
Hatteras Inlet Lighthouse bears.....S. ¼W.
North Methodist Church bears.....E.S.E. ½E.

Buoy No. 6.

Course to Buoy No. 7.....N. ¾W.
Course to Buoy No. 9.....S. x W. ¼W.
Roanoke Marsh Lighthouse bears.....N.E. ½E.
Signal Virginia .....N.W. ½N.

Buoy No. 7.

Course to Buoy No. 6.....S. ¾E.
Course to Buoy No. 8.....N.N.W. ½W.
Roanoke Marsh Lighthouse bears.....E. ¼S.
East side of two small islands on southeast side Roanoke Marshes bears .....S. x W. ¾W.

Buoy No. 8.

Course to Buoy No. 7.....S.S.E. ½E.
Course to Buoy No. 43.....N. x W.
Roanoke Marshes Lighthouse bears.....S.E. x E.
South end of island in mouth of creek in Roanoke Marshes bears .....S.W. ¼W.

Buoy No. 9.

Course to Buoy No. 6.....N. x E. ¼E.
Course to Buoy No. 10.....S. x E.
Roanoke Marshes Lighthouse bears.....N. x E. ¾E.
Signal Marsh bears.....N.W. x N.
Signal Sharp bears .....S.W. ¼W.

Buoy No. 10.

Course to Buoy No. 9.....N. x W.
Course to Buoy No. 11.....S. ½E.
Signal Stumpy Point bears.....S.S.W. ½W.
Signal Bend bears.....West.

Buoy No. 11.

Course to Buoy No. 10.....N. ½W.
Course to Buoy No. 15.....S. ¾W.
Signal Bend bears.....N.W. ¼W.
Signal Stumpy Point bears.....S.W. x W.

Buoy No. 12.

Course to Buoy No. 13.....N.E. x E.
Signal Stumpy Point bears.....N. ¼W.
Signal Sandy Point bears.....S. x W. ¾W.
Signal Bay bears.....S.W. ¾W.

Buoy No. 13.

Course to Buoy No. 14.....N.E. ½E.
Course to Buoy No. 12.....S.W. x W.
Signal Stumpy Point bears.....N.W. ¾N.
Signal Sandy Point bears.....S.S.W.

Buoy No. 14.

Course to Buoy No. 15.....N. x E. ¾E.
Course to Buoy No. 13.....S.W. ½S.
Signal Stumpy Point bears.....N.W. x W. ½W.
Signal Bend bears .....N. x W. ¾W.

Buoy No. 15.

Course to Buoy No. 11.....N. ¾E.
Course to Buoy No. 14.....S. x W. ¾W.
Signal Stumpy Point bears.....W. ¾N.
Signal Bend bears.....N.N.W. ¼W.

Buoy No. 16.

Course to Buoy No. 17.....S.S.E.
Signal Bay bears.....W.S.W.
Signal Sandy Point bears.....S. x W.
Signal Stumpy Point bears.....N. x E. ½E.

Buoy No. 17.

Course to Buoy No. 16.....N.N.W.
Course to Buoy No. 18.....W.S.W. ¼W.
Signal Sandy Point bears.....W.S.W. ¼W.
Signal Bay bears .....N.W. ¾W.

Buoy No. 18.

Course to Buoy No. 17.....N. ½W.
Course to Buoy No. 19.....S.S.W. ½W.
Signal Sandy Point bears.....W. x N.
Signal Long Shoal Point bears.....S. ¼W.
Signal Corn bears .....S.W. x W. ¾W.

Buoy No. 19.

Course to Buoy No. 18.....N.N.E. ½E.
Course to Buoy No. 23.....S.W.
Signal Sandy Point bears.....N.W.
Signal Corn bears .....W.S.W. ¾W.
Long Shoal Light House bears.....S. ¼E.

Buoy No. 20.

Course to Buoy No. 21.....E. ½N.
Cut Through Island bears.....N.W. ¼N.

Buoy No. 21.

Course to Buoy No. 22.....E. x N.
Course to Buoy No. 20.....N.E. ½N.
Signal Long Shoal Point bears.....N.E. ½N.
Cut Through Island bears.....W.N.W.

Buoy No. 22.

Course to Buoy No. 21.....W. x S.
Signal Long Shoal Point bears.....N. ½E.
Long Shoal Light House bears.....E. ¾S.

Buoy No. 23.

Course to Buoy No. 19.....N.E.
Signal Sandy Point bears.....N. x E.
Signal Corn bears .....N.W. ¼W.
Long Shoal Light House bears.....S.S.E. ¼E.

Buoy No. 24.

Course to Buoy No. 27.....S.S.E.
Course to Buoy No. 25.....S.W. x W. ¾W.
Oregon Inlet L. S. S. bears.....N.E. ¼N.
Davis House bears .....N.E. ¾N.
Bodie Island Light House bears.....N. x E. ½E.
Pea Island Club House bears.....E. x N.
New Inlet L.S.S. Old house bears.....E.S.E. ¾E.

Buoy No. 25.

Course to Buoy No. 24.....N.E. x E. ¾E.
Course to Buoy No. 26.....S.S.E.
Bodie Island Light House bears.....N.N.E.
Davis Fish House bears.....N.E.
Oregon Inlet L.S.S. bears.....N.E. ¼E.
Pea Island Club House bears.....E.N.E. ¾E.
New Inlet L.S.S. Old House bears.....E. ¾S.

Buoy No. 26.

Course to Buoy No. 25.....N.N.W.
Course to Buoy No. 31.....S.S.E.
Course to Buoy No. 27.....N.E. x E. ¼E.
Davis Fish House bears.....N.N.E. ¼E.
Pea Island Club House bears.....N.E. x E. ½E.
New Inlet L.S.S. Old House bears.....E. ½N.

Buoy No. 27.

Course to Buoy No. 24.....N.N.W.
Course to Buoy No. 28.....S.S.E.
Course of North Line New Inlet.....E. ½N.
Course to Buoy No. 26.....N.W. x W. ¾W.
Davis Fish House bears.....N. x E. ½E.
Pea Island Club House bears.....N.E. x E. ¼E.
New Inlet L.S.S. New House bears.....S.E. x E. ½E.
New Inlet L.S.S. Old House bears.....East.

Buoy No. 28.

Course to Buoy No. 27.....N.N.W.
Course to Buoy No. 29.....S.S.E.
Course to Buoy No. 31.....S.W.
Pea Island Club House bears.....N.E. ½N.
New Inlet L.S.S. Old House bears.....E.N.E.
New Inlet L.S.S. New House bears.....E.S.E. ¾E.
Course of South Line New Inlet.....E. ½N.

Buoy No. 29.

Course to Buoy No. 28.....N.N.W.
Course to Buoy No. 30.....S.W. x W. ½W.
Pea Island Club House bears.....N. x E. ¾E.
New Inlet L.S.S. Old House bears.....N.E. ½N.
New Inlet L.S.S. New House bears.....E.N.E. ½E.
Chicamicomico L.S.S. bears .....E. ½S.

Buoy No. 30.

Course to Buoy No. 31.....N.N.W.
Course to Buoy No. 29.....N.E. x E. ½E.
Pea Island Club House bears.....N.N.E. ¼E.
New Inlet L.S.S. Old House bears.....N.E. ½N.
Chicamicomico L.S.S. bears .....East.
Long Shoal Light House bears.....W.S.W. ¾W.

Buoy No. 31.

Course to Buoy No. 30.....S.S.E.
Course to Buoy No. 26.....N.N.W.
Course to Buoy No. 28.....N.E.
Long Shoal Light House bears.....S.W. x W. ¼W.
New Inlet L.S.S. Old House bears.....N.E. x E. ½E.
Chicamicomico L.S.S. bears .....E.S.E. ½E.
Pea Island Club House bears .....N.E. ½N.

Buoy No. 32.

Course to Buoy No. 33.....E.N.E.
Course to Buoy No. 37.....N.N.W.
Roanoke Marsh Light House bears.....N.N.W. ½W.
Bodie Island Light House bears.....N.E. ½N.
Oregon Inlet L.S.S. bears.....E.N.E. ¼E.
Davis Fish House bears.....E. ½N.

Buoy No. 33.

Course to Buoy No. 32.....W.S.W.
Course to Buoy No. 34.....E.N.E.
Course to Buoy No. 36.....N.N.W.
Roanoke Marsh Light House bears.....N.W. ½N.
Bodie Island Light House bears.....N.N.E. ½E.
Oregon L.S.S. bears.....E.N.E. ½E.
Davis Fish House bears.....E. x S.

Buoy No. 34.

Course to Buoy No. 33.....W.S.W.
Course to Buoy No. 35.....N.N.W.
Bodie Island Light House bears.....N. x E. ¼E.
Oregon Inlet L.S.S. bears.....E.N.E. ¼E.
Davis Fish House bears.....S.S.E.

Buoy No. 35.

Course to Buoy No. 34.....S.S.E.
Course to Buoy No. 36.....W.S.W.
Davis Fish House bears.....S.S.E.
Oregon Inlet L.S.S. bears.....E.S.E. ½E.
Bodie Island Light House bears.....N.E. x N.

Buoy No. 36.

Course to Buoy No. 35.....E.N.E.
Course to Buoy No. 33.....S.S.E.
Course to Buoy No. 37.....W.S.W.
Roanoke Marshes Light House bears.....N.W. ½W.
Bodie Island Light House bears.....N.E. ¼E.
Oregon Inlet L.S.S. bears.....E. ¼S.
Davis Fish House bears.....S.E. ¾E.

Buoy No. 37.

Course to Buoy No. 36.....E.N.E.
Course to Buoy No. 32.....S.S.E.
Roanoke Marshes Light House bears.....N.N.W. ¼W.
Bodie Island Light House bears.....N.E. ¾E.
Davis Fish House bears.....E.S.E. ¼E.

Buoy No. 38.

Course to Buoy No. 40.....E. ¾N.
Course to Buoy No. 42.....W.N.W. ¾W.
Signal Hog bears.....N. x E.
Bodie Island Light House bears.....E.N.E.

Buoy No. 39.

Course to Buoy No. 40.....S.S.W. ¼W.
Bodie Island Light House bears.....E.N.E. ½E.
Signal Hog bears .....E. ¾N.
Signal Duck bears .....S.E. x E.

Buoy No. 40.

Course to Buoy No. 39.....N.N.E. ½E.
Course to Buoy No. 38.....W. ¾S.
Signal Hog bears .....N.N.W. ¾W.
Bodie Island Light bears.....N.E. x E. ¾E.

Buoy No. 41.

Course to Buoy No. 42.....S.E. x E.
Course to Buoy No. 48.....N.W. ¼N.
Signal Hog bears .....E.N.E. ¾E.
Roanoke Marshes Light House bears.....W.N.W. ¼W.

Buoy No. 42.

Course to Buoy No. 41.....N.W. x W.
Course to Buoy No. 38.....E.S.E. ¾E.
Signal Hog bears .....N.E. x E.
Roanoke Marshes Light House bears.....W.N.W. ¼W.

Buoy No. 43.

Course to Buoy No. 8.....S. x E.
Course to Buoy No. 44.....N. x W. ¼W.
Roanoke Marshes Light House bears.....S.S.E.
Signal Dare bears .....S.W. x W. ½W.

Buoy No. 44.

Course to Buoy No. 43.....S. x E. ¼E.
Course to Buoy No. 45.....N.N.W. ¼W.
Blockade Shoal Beacon bears.....N.E. ¼E.
Roanoke Marshes Light House bears.....S. x E. ½E.
Signal Fleedwood bears .....W. ½S.

Buoy No. 45.

Course to Buoy No. 44.....S.S.E. ¼E.
Course to Buoy No. 46.....N. x W. ¾W.
Blockade Shoal Beacon bears.....S.E. x E.
Croatan Light House bears.....N.N.W.
Signal Redstone bears .....W. x S.

Buoy No. 46.

Course to Buoy No. 45.....S. x E. ¾E.
Course to Buoy No. 47.....N.N.W. ¼W.
Croatan Light House bears.....N.N.W. ¼W.
Signal N.W. Point bears.....West.

Buoy No. 47.

Course to Buoy No. 46.....S.S.E. ¼E.
Croatan Light House bears.....S.S.E.
North point at entrance to Mashoe's Creek bears.....S. x W. ¾W.

Buoy No. 48.

Course to Buoy No. 41 ..... S.E. ¼S.
Course to Buoy No. 49 ..... N. ½W.
Roanoke Marshes Light House bears ..... W. ¼N.
Fuerstein's Wharf House bears ..... N. ¾W.

Buoy No. 49.

Course to Buoy No. 48 ..... S. ½E.
Course to Buoy No. 50 ..... W.N.W.
Roanoke Marshes Light House bears ..... W. ½S.
Fuerstein's Wharf House bears ..... N. ¾W.

Buoy No. 50.

Course to Buoy No. 49 ..... E.S.E.
Fuerstein's Wharf House bears ..... N.E. ¼N.
Roanoke Marshes Light House bears ..... S.W. x W.

Buoy No. 51.

Course to Buoy No. 54 ..... N.E. x N.
Course to Buoy No. 58 ..... N. ½E.
Colerain's Wharf House bears ..... W ½N.

Buoy No. 52.

Course to Buoy No. 53 ..... N.N.E. ½E.
Course to Buoy No. 57 ..... N. ¾E.
Colerain's Wharf House bears ..... West.

Buoy No. 53.

Course to Buoy No. 52 ..... S.S.W. ½W.
Course to Buoy No. 56 ..... N.E. ¾N.
Foreman's Wharf House bears ..... S.E. ½E.

Buoy No. 54.

Course to Buoy No. 55 ..... N.E. x N.
Course to Buoy No. 51 ..... S.W. x S.
Foreman's Wharf bears ..... S.E. ½E.

Buoy No. 55.

Course to Buoy No. 54 ..... S.W. x S.
Signal Tuf bears ..... N.W. ¾W.
Woodley's Pier Beacon bears ..... E.S.E.

Buoy No. 56.

Course to Buoy No. 53 ..... S.W. ¾S.
Signal Tuf bears ..... N.W. ¾W.
Woodley's Pier Beacon bears ..... N.W. ¾W.

Buoy No. 57.

Course to Buoy No. 52 ..... S. ¾W.
Course to Buoy No. 59 ..... S. x E. ¾E.
Signal Cotton Flag bears ..... N.E. x E. ¾E.

Buoy No. 58.

Course to Buoy No. 51 ..... S. ½W.
Course to Buoy No. 60 ..... S. x E. ¾E.
Signal Cotton Flag bears ..... E.N.E.

Buoy No. 59.

Course to Buoy No. 57.....N. x W. ¾W.
Course to Buoy No. 62.....S. ¼W.
Signal Rocky Flag bears.....South.
Signal Lawrence bears .....W.N.W. ¾W.

Buoy No. 60.

Course to Buoy No. 58.....N. x W. ¾W.
Course to Buoy No. 61.....S. ¼W.
Signal Rocky Flag bears.....S.S.W. ½W.
Signal Lawrence bears .....W. x N.

Buoy No. 61.

Course to Buoy No. 60.....N. ¼E.
Course to Buoy No. 63.....S.E. x S.
Signal Black bears .....W.S.W. ¾W.
Signal Eden Point bears.....S. x E.

Buoy No. 62.

Course to Buoy No. 59.....N. ¼E.
Course to Buoy No. 64.....S.S.E. ½E.
Signal Empror bears .....W. ¾N.
Signal Eden Point bears.....

Buoy No. 63.

Course to Buoy No. 61.....N.E. x N.
Course to Buoy No. 65.....S.S.E. ½E.
Signal Eden Point bears.....W. x S.

Buoy No. 64.

Course to Buoy No. 62.....N.N.W. ½W.
Course to Buoy No. 66.....S.E. ½S.
Signal Eden Point bears.....W.S.W. ½W.

Buoy No. 65.

Course to Buoy No. 63.....N.N.W. ½W.
Signal Gum bears .....S.W.
Signal Eden Point bears .....N.W. ¼N.

Buoy No. 66.

Course to Buoy No. 64.....N.W. ½N.
Signal Cypress bears .....N.E.
Signal Eden Point bears.....N.W. x W. ¼W.

The work of Captain Rude did not complete the survey that was needed, and as the Fish Commissioner and his assistants, together with the boats, were required in patrol duty, the balance of the work was put off until the fall of 1910. The work was begun again, and when finished there will be a complete survey of the restricted areas in those counties under the jurisdiction of the Fish Commissioner. The work this fall has been done under the supervision of Mr. R. S. Patten.

The Fish Commissioner has made semi-annual reports to the Geological Board, covering the expenditures of the Commission and showing the work performed by the Commission. Statistics are being collected showing the kinds and number of nets that are being fished. The main work of the Commission at the present time is enforcing the laws relating to fishing in those counties under his jurisdiction. It is undoubtedly true that the operations of the Fish Commission in those counties over which its authority has been have been very beneficial to their fishing industries, and that the extension of the authority of the Commission over all the commercial fisheries of the State would have a similar beneficial result, and the State Geologist recommends to the General Assembly of 1911 that they pass such legislation as will bring under the jurisdiction of a Fisheries Commission all the fisheries in all the counties of North Carolina.

Oyster Industry.—There has been a large falling off in the catch of oysters in North Carolina for the past ten years, and while there are various causes that will account for this decrease, the main cause is undoubtedly the depletion of the natural oyster rocks or beds. In the following table is given the catch of oysters for the years 1901-1909:

CATCH OF OYSTERS IN NORTH CAROLINA, 1901–1908.

Season.	No. Bushels Oysters.	Receipts.	Disbursements.
1901–02	693,516	$8,560.30	$9,309.67
1902–03	658,769	19,328.41	18,189.86
1903–04	505,131	13,147.44	13,147.44
1904–05	531,854	8,749.93	9,148.40
1905–06	351,429	10,689.10	10,180.26
1906–07	349,979	5,191.08	6,282.88
1907–08	210,832	7,850.85	7,497.18

The one thing that will do more toward building up the oyster industry in North Carolina is the cultivation of the oyster, and, from the experiments that have been made by the North Carolina Geological and Economic Survey, in co-operation with the United States Bureau of Fisheries, it is undoubedly true that there is a large area in North Carolina in which oysters can be profitably cultivated. The leasing of these bottoms for oyster cultivation should

bring in revenue to the State which would more than cover the expense of looking after and protecting the oyster industry and at the same time build up to a very considerable extent the oyster industry in this State. The quality of the North Carolina oyster is such that there is no reason why it should not be definitely designated as a North Carolina oyster and put on the market as such. As it is at the present time nearly all the canned oysters are sold as Virginia oysters and a large part of the shell stock also is sold as Virginia oysters. The results of the experiments made by the Survey in oyster cultivation were published in 1907 as Bulletin 15. For three years none of these beds were examined, but in the spring of 1910 Mr. Henry D. Aller, Director of the Beaufort Laboratory of the United States Bureau of Fisheries, examined as far as possible the old plantings and reported as follows:

"As it had been over three years since any of the beds in Core or Pamlico Sounds had been visited by any one officially connected with the experimental work, it was not expected that any stakes marking the location of the beds would be found; and none were found. The Chain Shot bed was visited. The location of this bed was quite accurately known, and, furthermore, Mr. E. P. Gaskill, of Lupton, stated that he could take me to the precise place. At the place which he located a few oysters were found, and also shells which were probably some of those originally planted on this bed. Mr. Gaskill stated that this bed had been oystered and that he knew of there having been about 425 bushels of oysters taken from the bed. It is not known whether or not this quantity was taken in one season, but there seems to be no doubt as to this bed having been prolific.

"The region of the Harbor Island bed was also visited. As tongers do considerable work in this vicinity, and as there are numerous small beds about, it was considered useless to attempt to stake out the experimental bed.

"There is good reason to believe that the bed described as bed 'B' in Dr. Coker's report, and situated near the 'Thoroughfare' in Pains Bay, was located. I had this bed staked out. Its present size is about 100 feet by 100 feet. Other small patches of oysters were found in Pains Bay, but it was impossible to determine whether or not any of them were on the other beds planted in the bay. The oysters in this bay were considerably 'muddied,' but they were of fair size and of good shape and quality.

"Oysters were also obtained from an experimental bed in Newport River. These oysters were of fair size and first class in quality. The vicinity of this bed in Newport River has been thoroughly tonged over by oystermen, and the best of the oysters are undoubtedly removed annually.

"The circumstances attending this work rendered it impossible for me to add much that was new to our knowledge of oyster culture in this State. The facts ascertained, however, were all confirmatory of my opinion that oyster culture would be profitable if private planters could receive adequate protection. I also believe that it is the quite general opinion of those acquainted with the oystering business in this part of the State that oyster culture would be profitable under proper legislation provided the laws so enacted could be enforced. Practical knowledge regarding the culture of the oyster is undoubtedly far ahead of the public sentiment in favor of protecting private enterprise in such work."

This report of Mr. Aller's indicates that many beds that were planted for experimental purposes have grown to sufficient size to become workable beds, and that they are now annually tonged for oysters.

Perhaps the most suitable and practicable method of dealing with the fisheries of the State is to bring the control of all the commercial fisheries under a Fisheries Commission.

A few facts relating to the cultivation of the oyster and the leasing of bottoms for this purpose in other States may be of value to be included in this report:

Rhode Island leases the bottoms of her sounds and beds for oyster cultivation at a yearly rental of $10 per acre. Last year one of the commissioners reported at the annual meeting of the Shell-fish Commissioners, which was held at Mobile, that the State received something over $100,000 from rentals of the oyster bottoms.

In Connecticut instead of leasing the bottoms for oyster cultivation they have been sold outright for this purpose, so that the revenue that the State now derives is from the direct property tax on these bottoms. Mr. H. C. Corbin, Tax Commissioner of Connecticut, who attended the meeting of the Shell-fish Commissioners at Mobile, stated in an address:

"Connecticut has held that the oyster lands which were used for the growing of oysters are taxable on a basis similar to farm and

woodlands and were, therefore, rightly subject to the levying of an annual tax.

"The minimum valuation has been placed at $5 per acre, and the maximum valuation on the acres in deeper water at $150 per acre. Although there are some shore shoal grounds used largely for storage purposes, the lots of which having a small acreage are valued higher, to a maximum of $1,000 per acre.

"Connecticut holds that such property is properly taxable because the rights and the use and occupancy are protected by the State; because such property has a definite value; and, finally, because the State has committed itself to a general policy of protecting such lands from contamination, and in view of the recent events will undoubtedly develop an even more vigorous policy in this respect."

Mr. Corbin further stated that "while the State apparently wishes to protect the oyster growers in all of their property rights so far as it is able, it apparently does not consider that such property should be specially favored or privileged as compared with other stocks or property throughout the State."

There are certain other bottoms in Connecticut that have not been sold outright which are being leased. On the natural rocks any resident of the State may gather oysters upon being licensed for that purpose and paying a fee from $5 up, depending upon the tonnage of his boats.

In Maryland and Virginia laws have been passed within the last few years encouraging the cultivation of the oyster, and now large areas are being taken up in those States for this purpose. In Virginia the Oyster and Fish Commission are not only on a self-sustaining basis, but the State is able to derive a revenue from these industries.

Mr. J. A. Julian, Secretary of the Alabama Oyster Commission, in a paper on "Oyster Culture in the Gulf States," read before the meeting of the National Shell-fish Commissioners held at Mobile, stated that:

"Wherever the cultivation of oysters has been intelligently pursued satisfactory results have been invariably attained, notwithstanding the methods employed have been crude and primitive. With intelligent manipulation in the cultivation of the bottoms the yield overshadows the most sanguine expectations. The quintessence of the whole proposition lies in the application of organized efforts, and

the people who are interested in the upbuilding of the oyster industry of the Gulf coast are slowly awakening to the necessity of this. Thirty years ago the Gulf coast oysters were scarcely known beyond the confines of the bordering States. Today it is a factor in the oyster commerce of the United States that must be reckoned with, especially in the canning branch of the industry."

The two Gulf States that have done the most in regard to the cultivation of the oyster are Louisiana and Alabama, and the former State is now deriving a considerable revenue from the leasing of the bottoms of its sounds and bays for oyster cultivation.

The oyster grounds of these other States are no better than those of North Carolina, and there is no reason whatever, if the adequate laws are passed and enforced, why the oyster industry in this State should not become one of considerable magnitude, from which the State should derive a considerable revenue. At the present time the Oyster Commission does not have jurisdiction over all the oyster grounds of the State, and in order to obtain the best results the Fisheries Commission should have jurisdiction over all the commercial oyster grounds in North Carolina. As it is now in some counties bottoms can be leased for oyster cultivation, and in others they can not; in some the State taxes directly every bushel of oysters that is taken off the public oyster grounds, and in others there is no State tax. This is a discrimination that is working to the detriment of the oyster industry.

All the investigations that have been made, whether they relate to fish or oysters, emphasize the necessity of the State's having control of all the commercial fisheries.

EXPOSITIONS

Appalachian Exposition.—Upon the invitation of Dr. C. H. Gordon, Director of the Department of Mines and Forestry of the Appalachian Exposition, which was held at Knoxville, Tenn., in September and October, 1910, the North Carolina Geological and Economic Survey decided to make an exhibit in the building of this Department. The exhibit consisted of such minerals as offer opportunities for investment, specimens of North Carolina's lumber products, consisting of both hard and soft woods, and quite a number of maps, photographs and reports showing the work of the North Carolina Geological Survey. The exhibit in detail was as follows:

Minerals.—North Carolina's talc was well shown by a set of samples consisting of the crude talc, together with a large box of ground talc, and many samples showing the various forms in which talc is marketed. As is well known, North Carolina produces a very pure grade of talc, which is in great demand with manufacturers of talcum powder, etc. The talc exhibited was mainly from Swain County, and was furnished in great part by the North Carolina Talc and Mining Company, the chief representative of whom is Mr. F. R. Hewitt, of Asheville.

Another exhibit in which Mr. Hewitt figures very largely is in connection with the building stones. He furnished some slabs of pink and gray marble from a quarry which has but recently been opened in Swain County, and which gives promise of furnishing a most beautiful marble.

North Carolina's kaolin was exhibited in the crude form, and a pitcher made from North Carolina kaolin represented the finished product. This kaolin was partly furnished by the F. R. Hewitt Kaolin Company, and is from Swain County, North Carolina.

A very interesting display was made of North Carolina mica, representing the crude mica, ground mica and many forms in which it is cut for electrical purposes. A good portion of these specimens was furnished by the Great Southern Mica Company, of Jackson County.

A most interesting exhibit was that of monazite, the by-products obtained in separating the monazite from the crude sand, the rare earths obtained in extracting thoria from the monazite, and a series of samples showing the different stages of manufacture of the Welsbach burner. This exhibit was mainly furnished by the Carolinas Monazite Company, Cleveland County, N. C., and the Welsbach Light Co., Gloucester City, N. J. In connection with this exhibit was shown a Nernst Lamp, the glower of which is made from zirconia, a product of zircon, which is obtained from Henderson County, N. C.

Corundum was represented by a series of samples from Buck Creek, Clay County, and Shooting Creek, Macon County. There was also shown a number of emery and corundum wheels, razor hones, etc., illustrating the finished product of these abrasive materials.

Samples of tin from the Faires property, Cleveland County, were exhibited, and also a number of samples of chromite, chrome steel,

etc., showing the uses of chromium. This chromite was from mines in Yancey County, N. C.

Perhaps the exhibit of minerals that attracted the most general attention was the exhibit of gem minerals displayed in the two central cases of the exhibit. These represent in the rough the materials from which are obtained North Carolina's principal gems, such as the rhodolite and hiddenite (found in North Carolina exclusively), amethyst, beryls (blue, golden, aquamarine and white), rubies, garnets, sapphires, tourmalines, etc.

The building stones of the State were represented by large spheres of gray granite from the North Carolina Granite Corporation, Surry County; pink granite from the Balfour Quarry Company, Rowan County; white marble from Mitchell County; cubes of gray granite from Surry County, and some large slabs of pink and gray marble from Swain County. A small cube represented the orbicular-gabbro-diorite from Davie County, which is being put on the market by the Consolidated Granite Company, of Winston-Salem, N. C.

Forest Products.—Through the co-operation of a number of furniture and wood-using companies the Geological and Economic Survey was enabled to exhibit a rather complete set of samples of North Carolina's hardwoods and other timbers having furniture possibilities. These samples were furnished so as to show the wood as sawed and the kind of polish it would take. The Murphy Furniture Manufacturing Company, of Murphy, N. C., had eight pieces representing the different ways in which white oak can be cut, and one or two pieces representing red and black, or Spanish oak. The Hickory Furniture Company, of Hickory, N. C., sent a most beautiful line of samples representing North Carolina white oak, red oak, Spanish oak, poplars, basswood, yellow pine, white pine, linden, spruce, etc. The Waynesville Furniture Company, of Waynesville, N. C., sent some beautiful samples representing the various cuts of the oak. The Piedmont Wagon Company, of Hickory, N. C., furnished a series of samples showing the cut and polish of oak and hickory. They also included a number of samples of their finished product, showing the spokes, etc. The Gillsey Veneer Company, of Marion, N. C., furnished samples of work and poplar veneer showing their methods of sawing.

A number of each of the reports published by the North Carolina Geological and Economic Survey was placed for distribution to such

people as are interested in the various subjects treated, and it is believed that North Carolina's timber and mineral resources were well advertised by this exhibit.

A series of maps showed the results of the work done by the North Carolina Geological and Economic Survey in traverse and topographic mapping and in the working out of considerable of the geology of the State. One map showed the lines of great public highways that are being worked out by the North Carolina Geological and Economic Survey and the North Carolina Goods Roads Association, in co-operation with the various counties and communities through which they pass; and also shows the continuation of these highways into other States. An idea is given of the work of the Highway Division of the North Carolina Geological and Economic Survey by a series of pictures representing macadam, sand-clay and gravel roads already constructed in different parts of the State.

Over 1,000 copies of the various publications of the Geological Survey were carefully distributed during the period of the exposition besides about 1,000 lists of the publications of the Survey. Since the close of the exposition many inquiries have come in regarding the mineral and forest products of the State, and also requests for publications.

The State Geologist was assisted in the installation and care of the exhibit by Miss H. M. Berry and two students from the University of Tennessee.

State Fair.—The State Geological Survey has made an exhibit at the State Fair of 1909 and also 1910. These exhibits were very similar in character and scope to that made at the Appalachian Exposition.

PUBLICATIONS

The following publications have been issued by the North Carolina Geological and Economic Survey during the two years of 1909 and 1910, and embody the results of the investigations that have been briefly outlined above and to which references have been made:

BULLETINS.

18. Bibliography of North Carolina, Geology, Mineralogy, Geography, by Francis Baker Laney and Katharine Hill Wood, 1909. 428 pp.

20. Waterpowers of North Carolina, prepared in co-operation with the U. S. Geological Survey, 1910. 310 pp.

21. The Gold Hill Mining District, by Francis Baker Laney, 1910. 137 pp., 23 pl., 5 figs.

22. The Cid Mining District of Davidson County, by Joseph E. Pogue, Jr., 1910. 144 pp., 22 pl., 5 figs.

ECONOMIC PAPERS.

18. Proceedings of Drainage Convention, held at New Bern, N. C., compiled by Joseph Hyde Pratt, 1909. 50 pp.

19. Forest Fires of North Carolina During 1909, by J. S. Holmes, 1910. 48 pp., 9 pl.

20. Wood-using Industries of North Carolina, by Roger E. Simmons, J. S. Holmes, and H. S. Sackett, 1910. 69 pp., 6 pl.

GOOD ROADS CIRCULARS.

During the past two years eighteen Good Roads Circulars, numbers 43 to 60 inclusive, have been issued and distributed throughout the State by the Geological Survey. These have taken up and discussed the various questions relating to good roads work throughout the State, and all problems connected with good roads construction and maintenance and revenue for this work. The demand for some of these good roads circulars has been so great that it has been necessary to publish them in editions of three and four thousand.

PRESS BULLETINS.

During the past two fiscal years twenty-two Press Bulletins (20 to 42, inclusive) have been published and distributed by the Geological and Economic Survey. These Press bulletins, which have discussed various questions pertinent to the subjects of forestry, water-powers, drainage, fisheries, mining, etc., have been issued in order to keep constantly before the people of the State what work the Survey is doing, so that if they are interested in any particular line of work they will know when it is being taken up, and can obtain at an early date the information they desire regarding it. The Press Bulletins also call attention to the more detailed reports that the Survey is publishing and how these can be obtained. The following is a list of the Press Bulletins:

20. Forest Fires and Suggested Legislation for Their Prevention. 4 pp.

21. The Cultivation of the Oyster. 6 pp.

22. How to Increase the Durability of Farm Timber. 3 pp.

23. Suggested Legislation Relating to Drainage of Swamp and Overflowed Lands. 21 pp.

24. How to Plant Waste Land in Trees. 1 p.

25. Forest Fire Laws. 8 pp.
26. Fish Committee Meeting. 3 pp.
27. A Study of the Forest Conditions of North Carolina. 1 p.
28. A Study of Forest Fires in North Carolina. 1 p.
29. Drainage of North Carolina's Swamp and Overflowed Lands. 7 pp.
30. A Statistical Study of the Wood-using Industries of North Carolina. 3 pp.
31. Second Annual Meeting of North Carolina Drainage Association. 1 p.
32. Second Annual Meeting of North Carolina Drainage Association. 1 p.
33. Mineral Production of North Carolina During 1908. 1 p.
34. Forest Fires in North Carolina. 1 p.
35. Instructions and Suggestions to Engineers and Viewers on Drainage Districts. 7 pp.
36. The Stock Law and Forest Protection. 4 pp.
37. The Meeting of the Legislative Fish Committee. 2 pp.
38. Farming with Fire. 2 pp.
39. Great Damage from Recent Forest Fires. What Shall We Do About It? 8 pp.
40. Wood-using Industries of North Carolina. 4 pp.
41. The Third Annual Convention of the North Carolina Drainage Association. 3 pp.
42. The Third Annual Convention of the North Carolina Drainage Association. 3 pp.

The following reports are nearly ready for the press or are in the press, and should be ready for distribution early in 1911:

VOLUMES.

III, Part I, The Coastal Plain Region of North Carolina, by W. B. Clark, L. W. Stephenson, B. L. Miller and E. W. Berry.

Part II, The Underground Water Supply of the Coastal Plain Region, by L. W. Stephenson.

BULLETINS.

23. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe.
24. The Virgilina Copper District, a joint report by the North Carolina Geological and Economic Survey and the Virginia Geological Survey.
25. Timber Resources of the Sixteen Counties West of the Blue Ridge.

The following reports are in preparation:

VOLUMES.

Mineral Resources of North Carolina.
Mica and the Pegmatites of North Carolina.
Birds of North Carolina.

BULLETINS.

A List of Elevations in North Carolina.
Timber Resources of the Twenty-four Counties East of the Blue Ridge.
The Swamp Lands of North Carolina.

ECONOMIC PAPERS.

Tile Drainage.
The Mineral Production of North Carolina for 1908-1910.

FINANCIAL STATEMENT

The following statement will show the receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1910, grouped according to subjects investigated during this time. These are arranged separately for the two years. The receipts cover moneys received from the State Treasury, representing the annual appropriation and the sums received from counties and others for co-operative work of various kinds, as indicated:

DECEMBER 1, 1908, TO NOVEMBER 30, 1909.

Receipts.

Balance on hand	$4.04
Annual appropriation	10,000.00
Annual appropriation for highway department	3,750.00
Sale of typewriter	20.00
Co-operative work with Board of Education (forestry)	800.00
Franklin County, for traverse mapping	750.00
Cleveland County, for traverse mapping	300.00
Assay work	36.00

Disbursements.

General geological and mineralogical investigations and assaying	$720.77	
Coastal plain investigations	1,011.02	
Compiling bibliography of North Carolina	1,377.10	
Topographic and traverse mapping	1,836.56	
Forestry investigations	2,802.24	
Drainage investigations	556.22	
Water-power investigations	360.50	
Oyster and fish investigations	300.00	
Good roads investigations	4,366.66	
Geological board expenses	195.25	
Clerical and editorial work	1,405.74	
Office expenses balance	667.33	
Balance on hand	60.65	
	$15,660.04	$15,660.04

DECEMBER 1, 1909, TO NOVEMBER 30, 1910.

Receipts.

Balance on hand	$60.65
Annual appropriation	10,000.00
Annual appropriation for highway department	5,000.00
Assay work	12.00

For surveying crest of Blue Ridge highway through co-operation with private individuals	$2,500.00
Supplies sold by survey party	35.85
Amount received for work on Bingham Township road (co-operative)	70.00

Disbursements.

General geological and mineralogical investigations and assays	$552.72	
Coastal plain investigations	696.30	
Topographic and traverse mapping	18.00	
Forestry investigations	2,850.36	
Swamp land and drainage investigations	640.14	
Fish and oyster investigations	627.25	
Good road investigations	7,945.44	
Geological board expenses	129.25	
Clerical and editorial assistance	2,265.30	
Office expenses	1,951.86	
Balance on hand	1.88	
	$17,678.50	$17,678.50

HISTORICAL SKETCH

others interested in the work of the Survey to know something regarding the history of the North Carolina Geological Survey.

It is worthy of note that the first Geological Survey by public authority in America was established by the State of North Carolina. In 1823 an act of the General Assembly authorized the Board of Agriculture to pay the expenses of "geological excursions" for a period of years. This first work was begun by Professor Denison Olmsted, of the State University, and resulted in the publication of the following reports:

Descriptive catalogue of rocks and minerals collected in North Carolina.

Letter to the Board of Internal Improvements on the geology of North Carolina.

On the gold mines of North Carolina.

Red sandstone formation of North Carolina.

Report on the geology of North Carolina, conducted under the Board of Agriculture.

Thermometrical observations made by President Caldwell, at Chapel Hill, North Carolina, during the years 1820, 1821, 1822.

Useful minerals in North Carolina.

On the French Broad River, North Carolina.

The Ore Knob Copper Company.

ERRATUM.

First paragraph under "Historical Sketch," page 144, should read:

"It may be of interest to the members of the General Assembly and others interested in the work of the Survey to know something regarding the history of the North Carolina Geological Survey."

On his removal to Yale in 1825 the Survey was continued by Dr. Elisha Mitchell, also of the State University. Dr. Mitchell published the following reports in connection with his administration:

Altitude and soils of western North Carolina.

Diary of a geological tour by Dr. E. Mitchell in 1827-1828, with introduction and notes by Dr. Kemp P. Battle.

Elements of geology, with an outline of the geology of North Carolina.

Geological report of Professor Mitchell.

Notice of the height of mountains in North Carolina.

On the character and origin of the low country of North Carolina.

On the geology of the gold region of North Carolina.

Report on the geology of North Carolina, conducted under the Board of Agriculture.

Report on the turnpike from Raleigh, west.

In 1852 Dr. Ebenezer Emmons was appointed State Geologist, and during his regime a number of reports were published relating to the geology and natural history of the State, as follows:

Agriculture. Containing descriptions, with many analyses of the soils of the swamp lands.

Agriculture of North Carolina, Part II: containing a statement of the principles of the science upon which the practice of agriculture as an art are founded.

American geology, containing a statement of the principles of the science, with full illustrations of the characteristic American fossils.

Appendix to the special report made to .....Governor Bragg relative to the resources of the valley of Deep River and its advantages as a site for a national foundry.

The chemical constitution of certain of the Chatham series in the valley of Deep River, North Carolina.

Coal in North Carolina.

Geological and agricultural survey.

Geological report of the midland counties of North Carolina.

Gold veins in the syenetic of the Salisbury and Greensboro belt, North Carolina.

Manual of geology. Designed for the use of colleges and academies.

National foundry. Deep River, N. C. Special report concerning the advantages of the valley of the Deep River as a site for the establishment of a national foundry.

A national foundry in North Carolina.

North Carolina iron.

On age of trias in Virginia and North Carolina.

On new fossil corals from North Carolina.

Permian and triassic systems of North Carolina.

Remarks on the head of Clepsysaurus.

Report of Professor Emmons on his geological survey of North Carolina.

Report of the North Carolina Geological Survey. Agriculture of the eastern counties, together with descriptions of the fossils of the marl beds.

Report of the progress and present state of the geological and agricultural survey of North Carolina.

Report on the natural resources of that part of North Carolina west of the Blue Ridge.

Report on the Rhea mining property, Mecklenburg County, North Carolina.

On the death of Dr. Emmons, in 1866, Dr. W. C. Kerr was appointed State Geologist, who carried on the work until his death in 1885. During Dr. Kerr's administration the following reports and scientific notices were published:

Appendix to the report of the Geological Survey of North Carolina, 1873, being a brief abstract of that report, and a general description of the state, geological, geographical, climatic and agricultural.

The developed and undeveloped mineral wealth in North Carolina. Distribution and character of the eocene deposits in eastern North Carolina.

Geological relations of the topography of the south Appalachian plateau.

Geological survey of North Carolina.

The geology of Hatteras and the neighboring coast.

The gold gravels of North Carolina, their structure and origin.

Letters to the North Carolina Land Company, enumerating general resources of the State.

Marls of North Carolina.

The mica veins of North Carolina.

Mineral resources of North Carolina.

Minerals and mineral localities of North Carolina, being chapter 1 of the second volume of the Geology of North Carolina.

The minor minerals of North Carolina.

North Carolina, containing general description of the State and its resources, including geology, minerals, soils, forests and mining.

North Carolina building stones.

North Carolina resources, being a letter to the Governor describing resources of the State, and the geological investigations in progress.

Note on uranium minerals in North Carolina.

Observations on the mesozoic of North Carolina.

On frost drift in North Carolina.

On peculiarities of the mode of occurrence of gold in North Carolina.

On some points in the stratigraphy and surface geology of North Carolina.

On the action of frost in the arrangement of superficial earthy material.

On the death of Professor Kerr the Geological Survey was allowed to lapse until 1891, when it was placed on a different footing upon the establishment of the North Carolina Geological Survey and the appointment of Professor Joseph A. Holmes, of the State University, as State Geologist.

The object of this Survey, as expressed in the act of the General

Assembly authorizing it, was "the thorough examination of the nature and extent of the mineral and timber resources of the State." In the first biennial report of Professor Holmes he states:

"After a careful consideration of the work accomplished by preceding geological surveys in the State—under Emmons and Kerr—the results from both of these having been lost in large measure by not having been published, it was found that a considerable amount of general exploration would be necessary in many portions of the State before undertaking, or in connection with, the examination of special mineral deposits."

The work of this Survey resulted in the publication of a series of reports as follows:

BULLETINS.

Iron Ores of North Carolina, by Henry B. C. Nitze, 1893.

Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896.

Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893.

The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894.

The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897.

Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895.

Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899.

Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895.

Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897.

Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895.

Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897.

The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905.

ECONOMIC PAPERS.

The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897.

Recent Road Legislation in North Carolina, by J. A. Holmes.

Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900.

The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901.

Road Laws of North Carolina, by J. A. Holmes.

The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902.

The Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903.

The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904.

BIENNIAL REPORTS.

1. 1891-1892.
2. 1893-1894.
3. 1895-1896.
4. 1897-1898.
5. 1899-1900.
6. 1901-1902.
7. 1903-1904.

GOOD ROADS CIRCULARS, 1 TO 37, INCLUSIVE.

This Geological Survey continued its work until 1905, when the act creating it was repealed and a new act passed by the Legislature of 1905 establishing the present Survey, known as the North Carolina Geological and Economic Survey. During this year of 1905, and until October, 1906, Joseph Hyde Pratt, State Mineralogist, was Acting State Geologist in the absence of Professor Holmes, who was in St. Louis as Chief of the Department of Mines and Metallurgy of the Louisiana Purchase Exposition. On October 29, 1906, Dr. Joseph Hyde Pratt was formally appointed State Geologist by Governor R. B. Glenn.

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Postage 10 cents.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Postage 10 cents.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Postage 6 cents.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglass B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8. *In Press.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*

22. A Report on the Cid Mining District, by J. E. Pogue, Jr. *In Press.*

ECONOMIC PAPERS.

1. The Maple-Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Postage 2 cents.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varities of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the preparation of the incandescent mantles, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Postage 2 cents.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

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